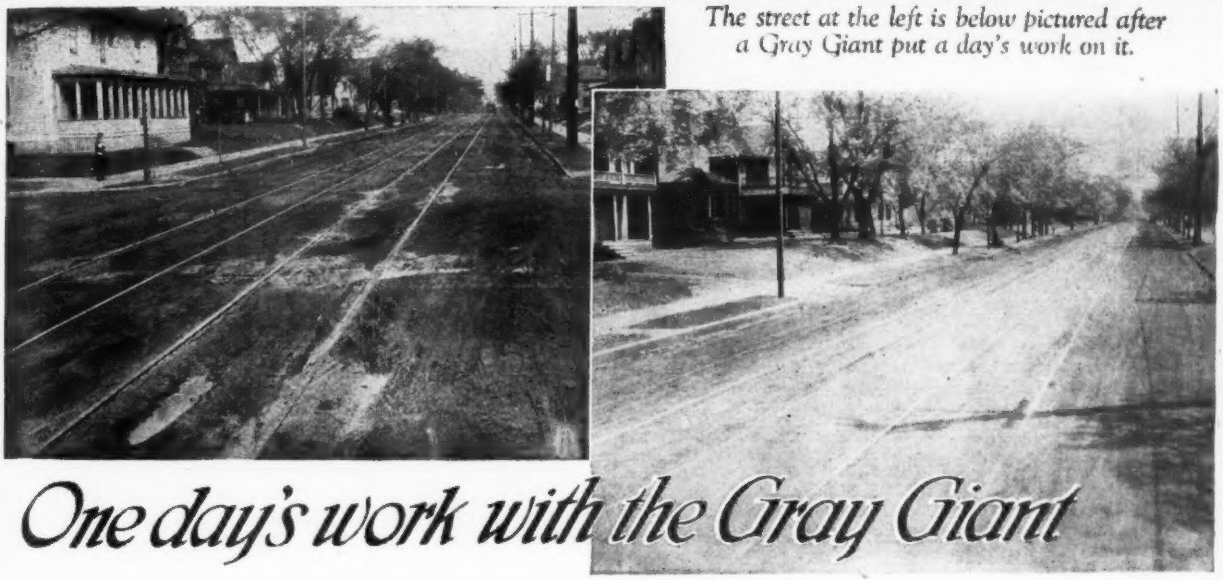
PUBLIC WORKS

CITY COUNTY STATE



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JULY, 1923

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"On Patchwork"

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PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 54 July, 1923 No. 7

Expediting Drying of Sewage Sludge

Initial de-watering of sludge by the use of alum with subsequent drying on stone beds. Experiments at Plainfield, N. J., plant reduced drying period, to less than one-third, even in wet weather.

In his report to the Plainfield, N. Plainfield and Dunellen Joint Sewer Meeting (the name given to the combination of municipalities that built and operates a sewage treatment plant at "Green Brook Park," N. J.) for the quarter ending May 31, 1923, John R. Downes, superintendent of the disposal works, discloses that working in co-operation with the New Jersey State Sewage Substation, he has been able to point out a principle of sludge treatment which has evidently escaped notice because of its very simplicity.

Every chemist considers thorough mixing of reagents almost essential to every reaction and the water chemist, familiar with the use of alum in treating water, knows the value of prompt and vigorous agitation in obtaining results. It is not strange, therefore, that those who have sought to treat sludge with alum have sought to obtain thorough mixing by means of agitation. The investigation at Plainfield was proceeding along these lines with somewhat indifferent though promising success, when the superintendent suggested that his long experience with sludges led him to believe that the violent agitation was undoing the work of the alum and even destroying the original tendency of the sludge to become drainable. Mixing was gradually cut down to what was considered a minimum with constantly improving results. After the supposed minimum had been reached the accidental misplacing of a barrel by a laborer lead to a further cut in agitation with great improvement in results and a cutting of the amount of alum required to a negligible quantity. Finally a stream of alum solution (100 pounds to 50 gallons of water) was allowed to run into the stream of flowing sludge just as the sludge left its channel to enter the drying bed. The reaction was completed in the bed itself, in com-

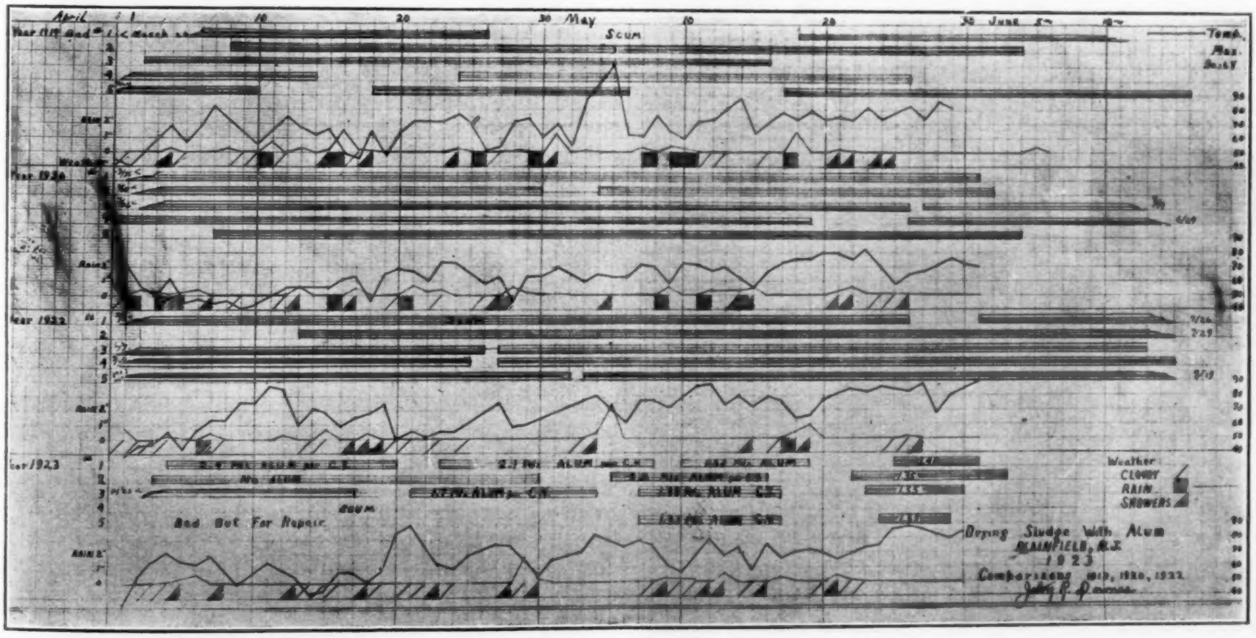


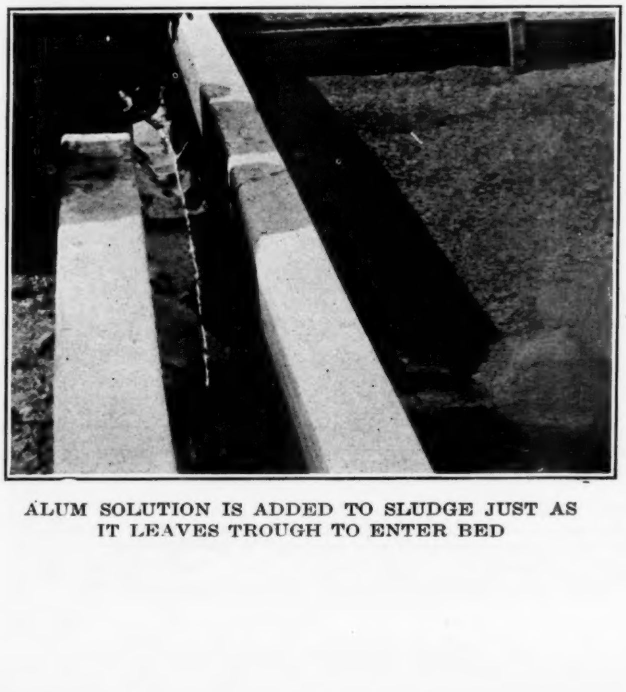
CHART SHOWING LENGTH OF TIME REQUIRED TO DRY SLUDGE TO A FORKABLE CONDITION.
The length of bar shows the number of days required for drying on each bed and with the amount of alum used as shown by figures on the bar. Records for 1919, 1920 and 1922 are shown for comparison.

parative quiescence. The sludge instantly congealed to a lava like consistency and free water ran out at the edges in the course of about twenty minutes.

The accompanying chart shows the length of time required to dry sludge to a condition in which it can be picked up on a stone fork with tines ¾ inch apart and removed from the bed. On the bars indicating the drying time in days for the year 1923, is indicated the dose of alum in pounds per cubic yard of sludge removed from the Imhoff tanks. The other years are shown for comparison, the year 1921 being omitted because no sludge was drawn at the corresponding period due to repairs to concrete. Weather conditions have been indicated on the chart.

More significant than the very short drying periods in the fair weather at the end of May, at a time when the necessity of minimum agitation was fully appreciated, is the success of the first treatment shown with rain on the freshly drawn sludge the day it was drawn and also the following day; a condition which would have required a great deal of time to overcome had the sludge not been treated. The check, drawn the previous day, escaped rain for nearly 48 hours at the start.

In fact this matter of making the sludge very largely independent of rainfall even during the first 24 hours is of great value. We have succeeded in drying sludge without treatment in from ten days to two weeks in perfect drying weather. Such weather, however, is not to be depended on over any extended periods and the result is that during six years of operation the average number of dryings per bed per year has been slightly under six. On the other hand, between April 4 and June 1, 1923, we completed four dryings of treated sludge on one bed. Taking the drying season as from April 1 to Nov. 1, or 214 days, 6 dryings per year equals about 33 days per drying as compared with an average of ten days per drying in the 11 dryings charted in 1923. These figures are averages and it has not been uncommon to have a bed tied up for 60 or 70 days with one dose of sludge.



ALUM SOLUTION IS ADDED TO SLUDGE JUST AS IT LEAVES TROUGH TO ENTER BED

The factor of chief interest to the three municipalities connected with the Joint Sewer at this time is the saving of from $8,000 to $10,000 which it had been planned to spend on new sludge drying beds. And this saving is accomplished at a cost of $100 per year for alum. Previous to 1923 it had never been possible to draw sludge as fast as it collected and ripened and each oncoming winter found an accumulation of sludge in the digestion tanks. In 1923 the second week in June found the digestion tanks free of all the sludge which it was thought practicable to move without upsetting the digestion balance.

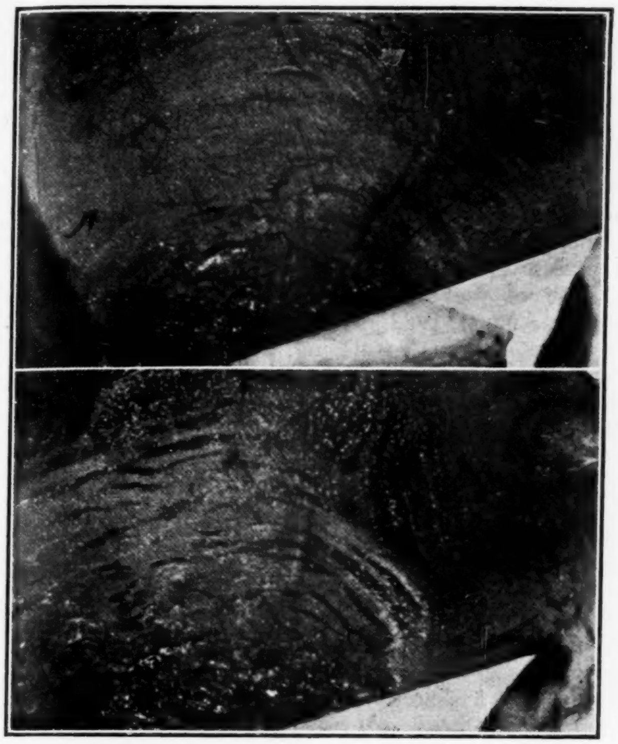
Application of the alum is simplicity itself. We know that we draw from the digestion tanks 110 cubic yards of sludge and that it takes about two hours to run this to the beds. A dose of alum for 110 cubic yards of sludge (roughly 150 pounds) is weighed up and put in two gunny sacks and one of the sacks suspended at the top of each of two barrels. The barrels are filled with water at night and in the morning the solution is found to be completed. The solution is stirred and kept stirred to make it uniform, and the flow adjusted so that the entire quantity of solution will be discharged in the same time period which it takes to draw the sludge. Irregularities in the flow of sludge are compensated for by the comparatively large size of the beds in which the reaction is completed.

The number of cubic yards of sludge removed from the tanks is calculated by measuring the depression of the water surface of the tank during the operation. In the case of the local sludge, a dose of 1.35 pounds of alum per cubic yard of sludge is sufficient. This equals about 1½ pounds of alum to a ton of sludge.

There is nothing critical about the dose and the expense is so small in any case that the method of treatment is available to all.

The treated sludge seems to be slightly less in volume when ready for removal from the bed, and is of a better texture for handling, being more fibrous and separating more readily from the material of the bed. This difference in physical texture between treated and untreated sludges is much more marked than the difference in moisture content (by drying at 105°C) which often seems negligible.

Mr. Downes, whose mail address is Bound Brook, N. J., is a member of the Research Committee of The N. J. Sewage Works Association and would appreciate the receipt of reports on the use of alum for sludge dewatering for the use of the Association, which has been strongly backing the experimental work of the sewage sub-station. To determine whether or not a sludge requires alum to assist in dewatering, take a sizeable sample in a glass jar. If clear liquid separates out at the exact bottom of the container, alum will probably be of little assistance. If, however, the liquid is murky or separates out at any point other than at the bottom, there is every reason to believe that alum will be beneficial.



Alum can be obtained in ten lots at about $1.75 per hundred, which makes the cost about $30 per year for each million gallons daily plant treatment.

LEFT-HAND COLUMN

Top—When dose of alum is sufficient, sludge at once curdles and becomes semi-solid, as shown here.

Middle—This shows the alum dose cut off, producing a watery surface that ripples freely as compared with the viscous, wrinkled appearance seen in the cut above.

Bottom—The concentric rings shown in the other photographs finally form great sweeping curves, along which cracking later occurs. To get the second picture the alum flow had been momentarily cut off. The effect a few moments later is seen in the bottom picture. The meandering streak with big surface bubbles at the center of the picture is the rippling flow without alum. On either side of this streak adequate alum treatment had been supplied.

RIGHT-HAND COLUMN

Top—Shows edge of creeping flow of treated sludge upon the bed and the crinkled surface.

Middle—The grey, V-shaped patch in the center is water draining out ahead of the slowly creeping mass of sludge at the end of the bed farthest from the outlet. Water begins to separate out at the edges 20 minutes after treatment is begun.

Bottom—Five hours after the bed had been filled with treated sludge, cracks developed as shown in this picture.

Activated Sludge Process

Principles and recent developments. Intermittent aeration. Mechanical aeration. Sludge de-watering and drying. Fertilizing value of sludge. Effluent for fish ponds.

An excellent, concise and clear account and description of the development and principles of the activated sludge process of sewage treatment was contributed by Prof. Edward Bartow, of the State University of Iowa, to a symposium on sewage treatment at the Fourth Conference on Sewage Treatment at Iowa State College. After giving a brief history of the experiments at the Lawrence station and the development of this process in England and later in this country, with which the readers of this paper are familiar, Prof. Bartow continued as follows:

The features of the process which have delayed its development are the cost of compressed air and the satisfactory drying of the sludge. Attempts have been made to decrease the cost of the air by using an intermittent flow, by so arranging the bottom that the minimum amount of air required for stirring may be used, and by methods of mechanical aeration.

The intermittent use of air has been tried in England, but without great success. Activated Sludge Limited, the English company which claims ownership of the English and American patents on the process, have devised a scheme at Manchester, England, in which diffuser plates are placed along one side of a long tank in such a manner that circular currents are set up. The liquid is kept saturated with sufficient air to support bacterial life, and the current is great enough to keep the sludge in suspension and prevent putrefaction. A comparative test made on the waste from a starch factory at Argo, Illinois, indicates a saving of at least 25 per cent of air by this arrangement.

MECHANICAL AERATION

The most successful system of mechanical aeration has been devised by Haworth, superintendent of the sewage-disposal works at Sheffield, England. He first used a box in which was installed a cylindrical mechanism which revolved at the surface of the liquid, partially submerged. The liquid was kept agitated by the mechanism and sufficient air carried into the liquid to support the bacterial life. Haworth's next scheme was by the use of a vertical shaft around which paddles, revolving, keep the liquid in motion through a long series of tanks. This was followed by the construction of a plant intended to handle 1,000,000 gallons of sewage per day, consisting of a long series of tanks four feet wide and four feet deep, with paddle wheels at intervals to carry the sewage and sludge at a sufficient rate to keep the sludge in suspension. This plant has been in operation for nearly two years with satisfaction. It is claimed that it will operate at a cost of twenty horse-power per 1,000,000 gallons for the other process stirred with air. With the approval of the British Board of Health, plans have been made for the construction at Sheffield of a plant of 15,000,000 Imperial gallons capacity. The first unit of two and one-half million gallons capacity will be in operation by March, and will be installed on the site of the contact beds which have become inadequate for the disposal of Sheffield sewage. The process in use at Sheffield has been imitated by the engineers of the city of Paris, France, for an experimental plant of 1,500,000 gallons capacity. The French engineers gave careful consideration to all processes and have constructed the mechanical aeration of the Haworth type. When I saw the plant in August, 1922, it had been in operation about six weeks and was furnishing, without odor, a clear stable effluent, much to the delight of the French engineers. John Watson at Birmingham, England, after preliminary tests has determined to use the Haworth type of mechanical filtration. It is his plan to partially purify sewage by activated sludge, and to finish the process by passing the effluent from the activated-sludge plant to the sprinkling filter beds which have been in operation for many years.

Another scheme for mechanical aeration has been devised by Joshua Bolton, of Bury, England. Mr. Bolton has used settling tanks of the old Bury system. In the center of tanks about twenty-four feet in diameter he has built wells of sheet iron three and one-half feet in diameter, extending nearly to the bottom of the tank. At the upper part of these wells he has placed a flange extending from a few inches below the surface of the water to a few inches above. Vanes are fastened to a vertical shaft revolving in the flange and carry water from the surface of the tank and throw it in a spray over the surface of the water in the tank outside of the well. Near the circumference of the tank is suspended a baffle which prevents the spray from being thrown to the outside of the tank, directs the mixed sludge and sewage towards the bottom and allows the clarified effluent to flow up on the outside into the outlet trough. In one tank a sloping bottom carries the settling sludge under the central well. In another a slow-moving mechanism, consisting of radial arms with plows, carries the sludge beneath the central well. Preliminary tests with this mechanism have been so satisfactory that the British Board of Health has authorized the construction of a larger plant. It is claimed that the cost of operation may be reduced to fourteen horse-power per 1,000,000 gallons, compared with the twenty horse-power claimed for the Haworth process and the thirty-five estimated for the diffuser process.

In the United States large plants using the diffuser scheme have been constructed at Houston, Texas, and in Chicago, Illinois, at the Maywood plant, and are being constructed at Milwaukee, Wisconsin, and Indianapolis, Indiana, and have been authorized for Chicago, Illinois, north side. Smaller plants are in operation at various points. At Mason City, Iowa, a plant has been installed for the treatment of waste from a packing house. I designed the plant to take care of the waste when one thousand hogs per day were being slaughtered. The plant consists of rectangular tanks containing aerators and a circular tank with a Dorr clarifier to allow the sludge to settle and from which it can be returned to the aeration

tank. When not overloaded this plant has operated successfully and the sludge has been dried and used in the by-products department.

No use has as yet been made in the United States of the mechanical principle. The mechanical device used at Sheffield would require much larger land areas than would be required for the diffuser process, and the cost of land might in some places prevent the use of the mechanical process.

THE SLUDGE PROBLEM

The second difficulty mentioned above, the dewatering and drying of the sludge, has been an object of investigation both in England and in the United States. Where the plants are running on an experimental basis at Manchester, the excess sludge is allowed to pass into the tanks or on to the drying beds used in the main process. At Worcester considerable land areas are covered with the sludge. Since the sludge contains from 98½ to 99½ per cent of moisture, and since it settles slowly and dries with difficulty, the disposal of sludge is a very serious problem. Centrifugal machines will reduce the moisture to approximately 90 per cent. The ordinary plate and frame filter-press will reduce the moisture to 79 or 82 per cent in the summer time. Experiments in the winter have often failed, unless the sludge has been warmed and treated with sulphuric acid or with alum. The best results have been obtained when the sludge has been warmed to a temperature of 150° F., and treated with sufficient acid or alum to cause the flocculent material to coagulate into larger masses. The best results obtained in America have been with an Oliver or American filter. These filters give a layer of sludge a little less than one-fourth inch thick, which will dry easily in the open air. The pressed cakes from a plate and frame press are one to one and one-half inches thick and when placed in the dryer are dried on the outside into an impervious layer which holds the remaining moisture inside. The rotary direct-heat dryers have been used for drying at Houston, Texas, without success. It is claimed that the experimental dryer at Milwaukee is satisfactory, and the Sanitary District of Chicago has installed a rotary dryer in its Maywood plant. The Maywood plant is about ready to operate and we will have some information concerning its operation in the near future.

An indirect-heat dryer manufactured by the Bayley Manufacturing Company has been used experimentally. The pressed cake used was too thick for satisfactory operation, and it is my belief that with the material obtained by the Oliver or American filter satisfactory results can be obtained with this apparatus.

The dried sludge obtained in the activated-sludge process contains from four to eight per cent nitrogen. This sludge has been tested by the approved methods for analyzing nitrogen and has been shown to be valuable as a fertilizer. It has also been tested by Lipmann in California, who states that the nitrogen is of the same grade as tankage for fertilizing purposes. With Mohlman, and later with Hatfield, I have made pot cultures on wheat and garden cultures on vegetables, and have shown that the nitrogen is in a form available to support plant life. Calculations from the pot cultures of wheat show a yield of nine bushels per acre when no fertilizer is used, and thirty-six bushels per acre when pots were fertilized by activated sludge. These experiments have been repeated by Nasmith at Guelph, and our results corroborated. Russell and Richards, at the Tothamsted experiment station in England, have shown that the activated sludge is valuable as a fertilizer. I visited Sir John Russell during the past summer, and was told that he had no doubt of the fertilizing value of the sludge. The next step was for the engineers to find a satisfactory method for drying the sludge. He would then use it in large scale demonstration tests to show its value to the farmers of England. The workmen at the Sheffield sewage-disposal plant have used activated sludge in fertilizing their gardens. These workmen took all the prizes for which they could compete at the Manchester garden exposition. They took the district prizes and the general prizes, twenty-seven in all.

Usually it is necessary to place grit chambers and screens in the purification plant ahead of the activated-sludge plant. Screens of any kind can be used, but we have had some experience with the Dorrco screen at the experiment station at Urbana, Illinois. The sewage enters a tank in which a cylindrical screen revolves at such a rate that screened sewage on the inside of the screen is drawn above the level of the unscreened sewage outside and flows out through the screen, automatically cleaning the screen. Screens of this type have been successfully used in the screening of tannery waste.

It has also occurred to me that the effluent from the activated-sludge plants might be used to form fish ponds. Fish ponds have been in operation at Strassburg, France, for about ten years. The effluent from settling tanks mixed with two or three times its volume of river water will support fish life. The activated sludge effluent is so much better that it should be satisfactory without dilution.

There has recently been published by the State Water Survey of Illinois a Bulletin (No. 18) describing investigations on activated sludge, conducted by the Survey during 1921 and 1922 and especially on tanks of the Dorr-Peck design. Owing, we believe, to the uneconomical features of this plant, the Dorr company has "given up any further work with this process," but the investigation developed several valuable conclusions relative to the activated sludge process.

One of the conclusions from these experiments, combined with others, is given in the bulletin in the form of a statement concerning the mechanism of the activated sludge process, as follows:

Activated sludge flocs are composed of a synthetic gelatinous matrix, similar to that of Nostoc or Merismopedia, in which filamentous and unicellular bacteria are imbedded and on which various protozoa and some metazoa crawl and feed. The purification is accomplished by ingestion and assimilation of the organic matter in the sewage by organisms, and its resynthesis by them into the living material of the flocs. This process changes organic matter from colloidal and dissolved states of dispersion to a state in which it will settle out.

Another conclusion is that, "unless the cost of operation can be very materially reduced or considerable

return realized on the sludge, the process will be of very limited application."

Rochester's Brighton Sewage Disposal Plant

The city of Rochester in 1916 completed a sewage disposal plant consisting of racks, grit chambers, Imhoff tank, sludge beds, dosing siphon, sprinkling filters and final settling basins, having a capacity for 15,000 people and parts of it for 30,000, although at present the population contributing sewage is only 8,000 or 9,000, and the plant is handling a little over one million gallons per day.

During 1922, 97.2% of the settling solids and 60% of the suspended solids were removed by the Imhoff tank; and the ultimate removal of suspended solids of the entire plant averaged 91.9%.

The site of this plant has been landscaped by the park department and is a popular picnic resort. In June it is surrounded with prairie roses, masses of shrubbery are planted along one side of the main drive and flowers on the other side, while through the trees is obtained a view of the bay a mile to the north. The total cost of the plant was $119,451, which includes $28,708 for the site, piping, etc. Concerning this plant John F. Skinner, Deputy City Engineer, a few weeks ago said: "This was the first one of our municipal sewage disposal plants completed. Its successful operation, dating from March 1, 1916, has justified the design of the plant, which has been intelligently operated under expert technical control so that its effluent is crystal clear and stable for upwards of twenty-one days at all times. Moreover, the effluent contains less suspended solids and more oxygen than the waters of Irondequoit Creek into which it flows."

Street-Cleaning in St. Paul

Of St. Paul's 536 miles of streets, 391 miles are graded only, 32 miles are paved with macadam, 11 miles with gravel and 102 miles with durable pavement.

A little over half of the paved streets, or 58 miles, are cleaned by hand-sweeping under the patrol system, the force consisting of an inspector at $150 per month, an assistant inspector at $125 per month, from 106 to 125 sweepers and 10 shovellers at $3.50 per day, and 10 teams at $1.00 per hour. The average cost per thousand square yards patrolled last year was $54.50. Each man is assigned from 3,200 square yards in the business section to 17,000 square yards in the residential section. In the former section, paved alleys are swept once a week by a crew consisting of 4 men and a team. Rubbish receptacles at the street corners have their contents removed by a single team with two helpers. The balance of the paved area is kept clean by ward crews.

In addition to the sweeping, all paved streets are cleaned periodically with water, using Studebaker flushers and one auto flusher. In the retail district seven miles of streets or 146,400 square yards is flushed every night, while in the outlying districts flushing is done at intervals. The cost of flushing the downtown district was $34.61 per thousand square yards for last season, while the average cost per thousand square yards for one flushing of the outlying paved streets was 29.3c.

During the season 186 miles of streets were water sprinkled and 177 miles were treated with oil, there being used for this purpose 105 horse-drawn tank wagons, the teamsters receiving $200 per month, and four Kinney auto oilers. The cost of sprinkling and oiling is assessed against the abutting property, the aim being to charge the exact cost of the service. Last season the rate for sprinkling, four trips per day, was 9.8c per front foot; and the rate for oiling, two oilings per season, was 7.6c per front foot, the average width being 27 feet. The auto oiler distributed 625,500 gallons of road oil at a cost for oil of 7.4c per gallon and for spreading of $9.86 per thousand gallons.

Clay Pipe in Plumbing Systems

Two prizes, one of $100 and a second of $50, have been awarded for essays on the subject of "The Use of Vitrified Clay Pipe in Plumbing Systems." The contest was conducted by the Carnegie Institute of Technology and the prizes donated by the Eastern Clay Products Company. The first prize was awarded to William E. Morgan, of Salisbury, Maryland, a sophomore at Carnegie Institute, and the second prize to Thomas F. Moffett, of Saranac Lake, New York, for nine years a master plumber in the Bronx district of New York City. The judges were headed by Prof. S. E. Dibble, head of the Department of Plumbing, Heating and Ventilating in Carnegie Institute, while the other members of the jury were W. J. Woolley, secretary-manager of the National Trade Extension Bureau; Joseph A. Welden, master plumber of Pittsburgh, and John T. Morris, director of the College of Industry of Carnegie Institute.

Susquehanna River Power Dam

Perhaps the greatest single power development contemplated in the Middle Atlantic States at the present time is that planned by the Susquehanna Power Company, consisting of a hydro-electric plant on the Susquehanna river about half-way between Philadelphia and Baltimore. Five sites are being investigated, located between the head of tidewater and the town of Conoquingo, Maryland.

The plans call for the erection of a power plant with an ultimate capacity of 360,000 horsepower, created by a dam about 110 feet high. As required by the Federal Power Commission Act, application for permission to build the dam has been advertised. The company has obtained articles of incorporation from Maryland and has made application to the state of Pennsylvania. In the application the company states that the energy would be transmitted to places within a hundred miles radius to supply local demands. This radius includes Philadelphia, Baltimore, Washington, Wilmington and Trenton.

Construction of Connors Creek Sewer

By Carl Ashley

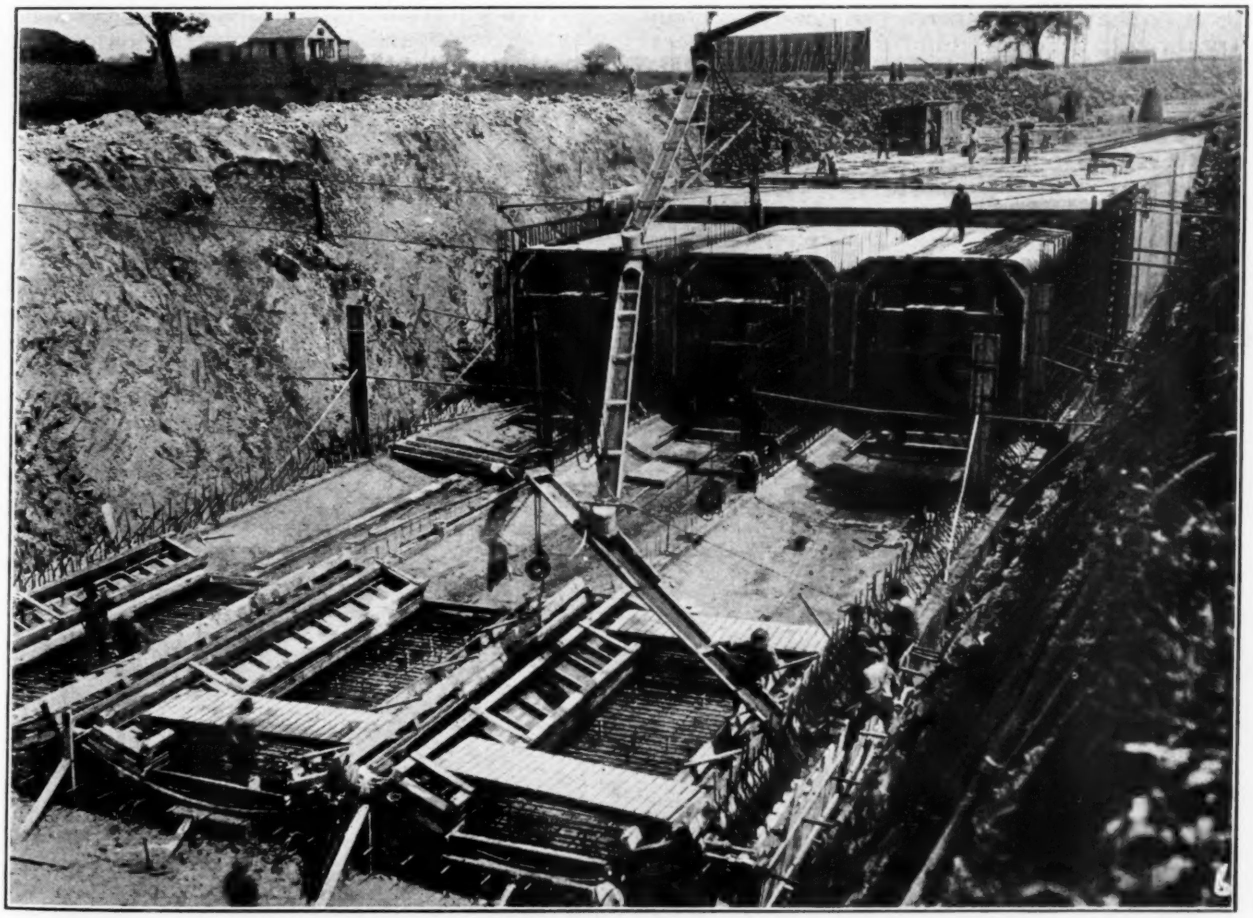
Construction methods on a triple sewer with a cross-section of 800 square feet, by means of which work was completed on the entire mile and a half in nineteen months, seven months before date set by contract.

On March 29th, 1921, bids were received for the construction of Section 1, Connors Creek Sewer, and on April 5th, 1921, the contract was awarded to the Gillespie Contracting Company of Detroit and New York. The date set for completion was June 1st, 1923, but the entire sewer was finished November 15th, 1922; in fact, with the exception of joining a short section under the tracks of the Detroit Terminal Railroad, all concreting was completed in September, 1922.

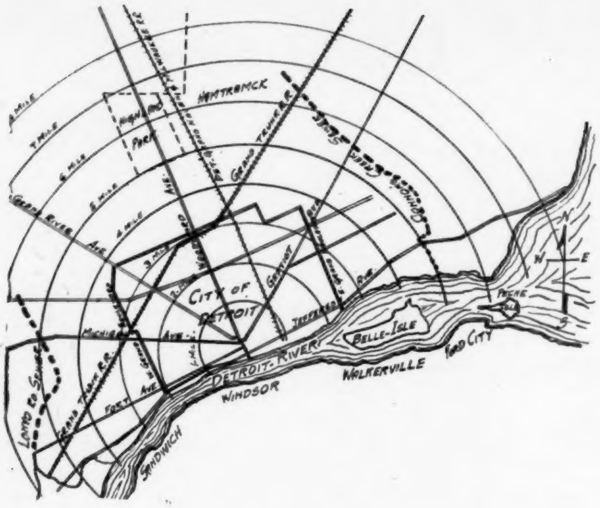
A general description of the sewer appeared in Public Works for March 11, 1922, and Detroit's sewer system has been extensively discussed in other engineering and contracting papers, but the contractors have been asked for an article and illustrations covering the work from a construction point of view.

The small map shows the location of the Lonyo Road and Connors Creek trunk sewers, which both follow natural drainage of existing streams. Connors Creek will be diverted from its natural channel and turned into the completed section before cold weather sets in. As the trunk sewer is completed northward, Connors Creek will be turned into each completed section. The length of Section 1 is 7,700 feet.

The entire Connors Creek system will drain



POURING CONCRETE. FINISHED INVERTS IN FOREGROUND. FINISHED SEWER IN BACKGROUND. FORMS SET AHEAD OF SEWER.



MAP SHOWING LOCATION OF CONNORS CREEK AND LONYO ROAD SEWERS.

forty-one square miles and is designed to care for a discharge of five thousand cubic feet per second when flowing full up to six inches below the roof. This discharge is not expected for many years to come, when the city has built up in the suburbs. The sewer will always be about seventy-five per cent. full in Section 1, due to the invert being about thirteen feet below the level of the Detroit river. The low-lying country through which Section 1 is built makes necessary the three large barrels, each 15′ 9″ wide by 17′ 6″ high, as shown in sectional view.

From the Detroit river north to midway between Jefferson and Kercheval avenues, the sewer is at present in open channel. Section 1 starts in the bed of Connors creek 600 ft. south of Kercheval avenue, follows the creek bed for 400 ft., passes under the tracks of the Detroit Terminal R. R., turns a right angle into Kercheval avenue, which it follows a short distance and then turns another right angle north into Connors avenue, in which the remainder of Section 1 is located—about 6,750 ft. Section 2, recently let, follows Connors avenue to Shoemaker avenue, a distance of 2,800 ft., where it enters upon city-owned land which will eventually be used for an outer park and drive. The total length of Connors creek sewer will be about seven miles.

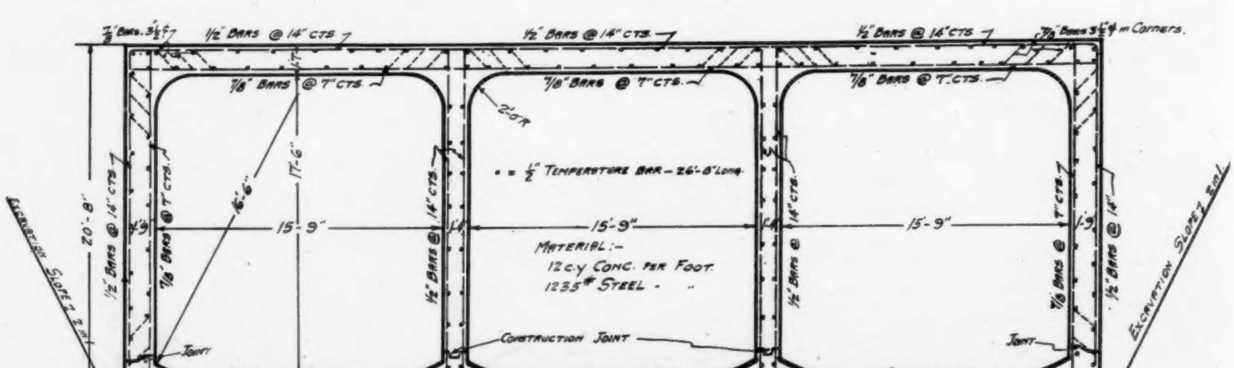
While the inside dimensions of the sewer are the same throughout, four various sections of reinforced concrete walls were built as follows, starting from the lower end of the work:

	Length	Concrete per ft.	Steel per ft.	Loading conditions
Sec. AA	350′	17 Yds.	2,930 lbs.	Steel billets in factory yard.
" A	282′	14 "	1,970 "	Det. Term. R. R.& fact'y coal yard.
" B	4,268′	11 "	1,130 "	Street fill, 1 ft. to 8 ft. deep.
" C	2,800′	12 "	1,235 "	Street fill, 8 ft. to 13 ft. deep.

The accompanying cross section shows the type of walls, roof and reinforcing steel used in Section C. All temperature steel was lapped 40 diameters at construction joints, so that the entire 7,700 ft. of sewer is practically a continuous structure. The cup bar of the Carnegie Steel Company was employed throughout. All bent bars were bent in the shops of the Concrete Steel Company, Youngstown, Ohio, forty per cent. of the total used being bent.

Active work was started early in May, 1921, on plant erection and laying construction tracks. The sketch and photograph show type of central proportioning plant for dry mix.

The cement house is 30 ft. x 130 ft., capacity 8,000 bbls., with gravel bin 21 ft. x 37 ft. at both ends. Each gravel bin has a capacity of 500 yards. The 36″ gauge track for concrete trains passes through the center as indicated on sketch. The location of the railroad tracks is such as to permit of unloading cement and gravel to the concrete trains or stocking it as the case may be. The capacity of the gravel bins is sufficient for a day's run in case of derrick failure. Steam pipes are installed in gravel bins for winter work. Maximum storage capacity is 9,000 cu. yds. One-yard Koppel cars were used in six-



CROSS-SECTION OF SEWERS, SECTION C.

car and nine-car trains to transport dry mix from the cental plant to concrete mixers. Four-ton Burton gasoline locomotives and steam locomotives were used to haul concrete trains, average haul being one-third mile. The gas locomotives were employed in switching and charging the concrete trains and steam locomotives were used chiefly in hauling trains to the mixers. A daily average of 600 cu. yds. of concrete per day was maintained when both mixers worked.

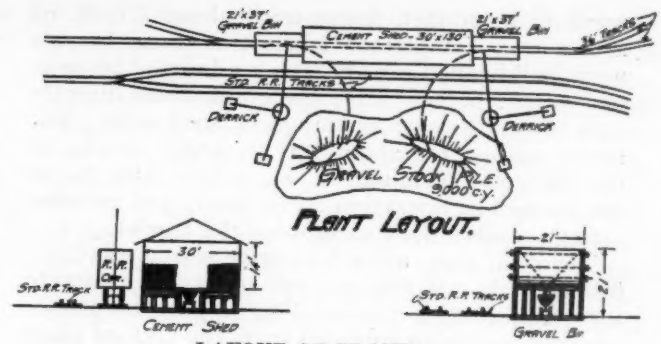
Two movable concrete mixing plants were installed upon bank of cut and moved forward on rollers of greased rails as the work progressed. The platform was 18 ft. x 30 ft. equipped with one-yard Lakewood Standard mixer, 45 ft. spouting tower, 30 h. p. boiler and concrete hoisting engine. From the tower hopper the concrete was distributed by a 50 ft. counterweight swinging chute. The sewer was built in two operations, the invert being kept about 100 ft. in advance of the completed arch as shown in photograph. All concrete equipment was of Lakewood make.

Collapsible telescopic steel forms from the Blaw-Knox Co. were employed on the straight portion of the sewer in Connors avenue. In 1921 a twenty-foot form was used, but during the winter of 1921-22 the forms were all lengthened to twenty-five feet in order to increase daily output. Four sets of forms were used in each barrel.

For winter concreting the outside steel forms were equipped with steam pipes covered with wood, the exposed roof being covered and live steam played over the concrete. The inside of the sewer chambers was heated by salamanders. Twenty feet per day was built up to December 21st last year and no signs of freezing were ever encountered, although the concrete was typically a reinforced structure with thin walls exposed to the cold.

The first right angle curve at Kercheval avenue was constructed with built up wood forms, knocked down and rebuilt entirely. The second right angle curve had only one permanent collapsible wood form with curved walers to fit the walls. This form was pulled along as work advanced.

The excavation, as is usual in sewer work, presented the great difficulty. The sewer structure is 54 ft. wide at bottom of cut, which averages 28 ft. deep with top width of 82 ft. As the city allowed merely the street as right of way—viz.: 60 ft., the contractor was obliged to rent lands on each side for his dump tracks and concrete mixing plants. From the Detroit Terminal railroad tracks north for 2,400 ft. all excavation was made by a No. 20 Bucyrus dragline using Page bucket. The excavated material was loaded upon four-yard dump cars and either dumped in sewer



LAYOUT OF PLANT.

backfill or deposited in low-lying lands obtained by the contractor for that purpose. In Kercheval avenue, 80 ft. wide, the sewer passes alongside brick buildings, and 14" arch web Lackawanna steel piling was driven to support sides of cut. The dragline excavated as much as possible without endangering the banks, after which 18" I beam walers with 54 ft. latticed steel struts across cut were placed. The remainder of the excavation was removed by a two-yard Williams clamshell. The clay was too stiff for a clamshell and excavating Detroit clay by a clamshell is to be at all times avoided. A second set of walers and struts was always placed to prevent bending of sheeting and consequent cracking of walls.

In the upper 4,900 ft. of the section, the top 12 to 18 ft. was dug by a No. 70-C Bucyrus steam shovel, a No. 20 Bucyrus dragline following in the cut and finishing excavation to grade. As a rule the banks would stand at a slope of two on one. The upper portion of the cut was yellow clay which breaks up on digging and dumps readily from the cars, but the lower portion was of blue clay that is very stiff and dumps hard. In fact, the dumping of excavated material is the most difficult phase of the daily progress, when an average excavation of 3,000 yds. per day is the mark set.

The portion in Connors creek bed and under the railroad tracks was constructed by an independent operation, using one-yard Williams clamshell on either derrick or locomotive crane. Concrete was deposited by bucket and Koppel cars. The flow of Connors creek was by-passed around

CONCRETE TRAIN PASSING THROUGH CEMENT SHED AND GRAVEL BIN.

work in a wooden flume until about 250 ft. of sewer was completed, when the three barrels were bulkheaded off and creek admitted to sewer. At the present time the creek flows directly into sewer through openings in west wall. The sewer passes for about 200 ft. under tracks of the Detroit Terminal R. R., which had to be maintained in operation. Pile bents and wooden stringers were used to support the tracks.

The total excavation for entire sewer was 551,000 cu. yds.; 90,000 cu. yds. of 1:2:4 concrete were required, a combined aggregate of proper proportions being supplied from the Oxford plant of the Ward Sand & Gravel Company. Peerless Portland cement from Union City, Mich., was employed throughout. A total of 4,900 tons of reinforcing steel was placed. The layout work and inspection are performed by inspectors from the Department of Public Works, Joseph A. Martin, Commissioner.

On August 25th of this year bids were received for Section 2, Connors Creek sewer, 10,630 ft. long. Alternate plans were proposed for a five-centered 18′ 9″ x 25′ 8″ reinforced concrete arch, or a two-barrel section, each barrel 12′ 0″ wide x 17′ 6″ high. The T. A. Gillespie Company was low bidder on both types, bidding $100.50 per ft. for the arch and $113.30 per ft. for the two-barrel. After deliberation the city awarded the contract for the two-barrel type on September 19th, 1922. Work was started at once and is now under way. The grade of the two-barrel sewer is .15 ft. per 100 ft., while that of the sewer in Section No. 1 was .035 ft., which permits a reduction of almost fifty per cent. in cross-section area without loss in capacity.

Trench Excavating Machinery in Brockton

By Harold S. Crocker*

Even with the small amount of building during the war period, the Brockton Sewer Department failed to keep pace with the demand for sewer extension. The labor market was inadequate, and the only solution was machinery, even regardless of cost.

New layouts had demanded new main collectors in several localities, resulting in each case in fairly deep cuts.

In 1920, after careful investigation, it seemed wise to purchase a Parsons excavator, size 36, and a backfiller of the same make. The excavator will dig a trench to any desired depth up to 15 feet, and from 24 to 36 inches in width. The original costs of the machines were $10,350 and $2,500, respectively, unloaded at Brockton.

The excavator was received in July, and was on the work that year 772 hours, of which it was in actual operation 374. The crew consisted of three men, the operator and two laborers, whose duty it was to remove the rocks encountered, and with bars break down the banks of the trench in cases where necessary when pipe was to be laid that required a trench wider than thirty-six inches.

Overhead was figured as the depreciation on the machine at 20% annually, or 10% for that half year, which amounted to $1,035, and interest for the six months at 5% (the interest paid on bonds that year) which added $258.75. The new parts, practically all of which were buckets and teeth, with the labor thereon, amounted to $196.61. The direct labor, charged whether the machine operated or not, was $1,813.76; gas and oil cost $232.51. The total cost that year was $3,537.39, and the machine removed 4,291 cubic yards of material, making a cost per yard of $.823. The cuts varied in depth from six to fifteen feet and average about eight and one-half feet.

In 1921 the total overhead, including 20% depreciation, or $2,070.00, and 5% interest, or $517.50, together with cost of overhauling, amounted to $3,883.31, and the total cost of operation was $11,811.92. The machine was in actual operation only about one-half the time that labor was charged against it because of bad weather conditions, days when the bracers could not keep up with the speed of the machine, or the pipe-layers could not acquire a speed sufficient to maintain the pace of either, and where it was unwise to purchase more sheeting because of the high price of plank. It removed 11,402 cubic yards in an average cut of over ten feet, making the cost per yard $1.036.

The 1922 work was similar to that of 1921, and the cost was about the same.

The machine is now on its fourth season, and I am convinced that the depreciation figure is too large. From the present indication, it could well be halved.

All kinds of material are encountered in Brockton, and the excavator will remove anything but ledge. Stone up to the size of one's head can be removed without stopping the machine. Much larger ones are brought to the surface and there removed to the bank by hand. There is no question but that the machine will dig anywhere, and remove material much cheaper than it can be dug by hand. The lowest figure on any street to date has been in gravel, where few large stones were encountered, and an average cut of about seven feet. That job cost forty-two cents per yard. With the depreciation figure as low as I suggested it might well be, the cost would have been reduced ten cents.

The backfiller, with overhead figured by the same method and with a crew of three men for puddling and tamping beside the operator, has replaced material for twenty-three cents per cubic yard.

While these figures do not compare favorably with some that have been called to my attention, yet with the varied soil conditions and large quantity of stone and boulders found in the city

*City engineer, Brockton, Mass.

the results are very satisfactory, and the work is being done far cheaper than it could be accomplished by hand.

Water Consumption in Charleston

The report of the Water Department of Charleston, S. C., for the year 1922 states that the services were 100% metered throughout the year and that a comparison of the total water pumped to the city mains during the year, as measured by the master meter at the pumping station, and the sum of all the amounts registered by the service meters show 80.1% of the water accounted for. There was a general increase in the accounted-for water during the year, it having reached 86.5% in November and 86.6% in December.

The total amount of water consumed during the year was 2,237,620,000 gallons, of which 623,600,000 passed through domestic meters and 1,168,000,000 through industrial meters, leaving 446,020,000 as unaccounted for. Part of this was used at fires, but the greater part was probably leakage or under registration of consumers' meters. The total number of meters in use in December was 8,923 on domestic services and 171 on industrial.

In 1918, with 76% of the active services metered, the per cent of water accounted for was under 50. In 1919, with about 88% of the services metered, the amount accounted for was about 70%.

Sewer Trenching by Dragline

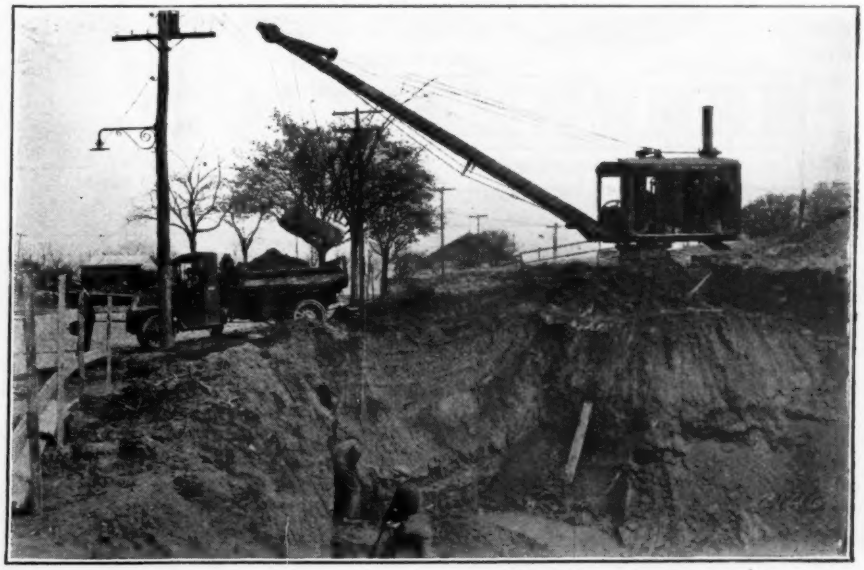
A sewage disposal plant is being constructed for the Borough of Queens, New York City—one of several which the city is constructing at different points along its waterfront—the essential part of which is a 14-foot Riensch Wurl screen. To lead the sewage to this screen there is being constructed 1,100 feet of reinforced concrete sanitary sewer 9 feet in diameter, and 1,250 feet of reinforced concrete storm water sewer, 14 feet by 8 feet. These two sewers are located side by side in a single trench, with a space of 3 feet 8 inches between them, thus requiring a trench about 35 feet wide, allowance being made for sheeting and bracing. This trench has an average depth of about 26 feet, but reaches a maximum depth of 38 feet. The material excavated is a sandy clay on top, with fine, hard sand below. The bottom of the trench reaches from 5 to 7 feet below high water. The contract for constructing the sewers was let to Booth & Flynn, Ltd., for whom M. L. Quinn is acting as general superintendent.

The sewers pass through an undeveloped section, the street in which they are laid out not yet having been opened, so that there is ample room for casting the excavated material along one side of the trench. For excavating, the contractors decided to use a dragline, an Osgood ¾-yard being used, operated by steam power and equipped with a 45-foot boom and a Page dragline bucket. The dragline travels on the surface within and near one side of the line of the trench and drags the excavation in a circular fashion with and across the cut. The bucket discharges its load into motor trucks, loads between trucks being cast on the opposite bank well back from the cut. One bank is thus kept clear for the passage of the trucks and also of a traveling derrick which is used in excavating the bottom half of the trench.

The dragline is used to a depth of from 13 to 21 feet, depending on the stiffness of the soil, before the trench is sheeted, the banks being sloped slightly, giving the trench a width of about 40 feet at the top. It is not generally practicable to use a dragline in a trench with sheeting and bracing, although in this work it has been used to some extent in the sheeted sections, working between the bracing. The average progress has been about 350 yards during an 8-hour day.

Following the opening of the top half of the trench with the dragline, the bottom half is sheeted and excavated by means of a traveling derrick in the more usual manner. In constructing the sewers, Blaw-Knox steel forms are used and a traveling mixer plant located on the top of the trench. The spoil bank left by the dragline is used for backfilling.

The work is under the direction of Frank Perrine, engineer of sewers for the Borough of Queens.



DIGGING SEWER IN QUEENS BOROUGH WITH A DRAGLINE.

Segment Block Sewer Loaded to Destruction

By Henry A. Pulliam*

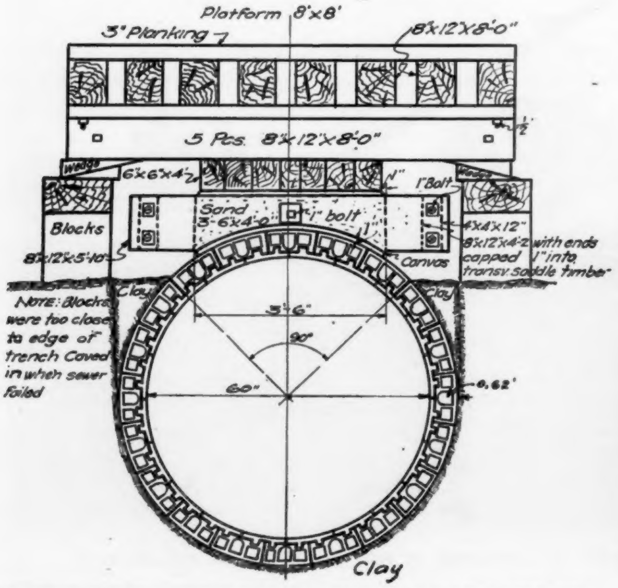
Test of an eight-foot section of sixty-inch sewer, to determine its acceptability by the cities of Paducah and St. Louis, made by city official.

A new design of vitrified clay segment-block sewer, made by the LaClede-Christy Clay Products Co., was adopted for a part of the $1,500,000 sewerage program in Paducah, Kentucky, the adoption being subject to load tests that would determine its structural strength.

One of the tests of this block was completed May 25, 1923, in St. Louis, supervised by Guy Brown.† The results of this test were furthermore to be used in determining the acceptability of the block by the city of St. Louis. A sixty-inch sewer was built in the yards of the municipal asphalt plant and loaded to destruction. The breaking load was 137,007 pounds. The length of the test section of the sewer was 8 feet, the bearing surface of the pressure saddle being merely on the middle four feet. The width of the bearing surface was 3½ feet, confining the pressure to 14 square feet on top of the sewer, measured horizontally.

The Foundation—The earth on which the sewer rested was a soft clay, of a sort approximating the average construction conditions of that locality. The bottom was shaped in a circular manner to exactly fit the sewer, a procedure which is to be sought in the actual construction of this type of sewer.

*Commissioner of Public Works and City Engineer of Paducah, Ky.
†Principal Assistant Engineer of Sewer Design of St. Louis.



SADDLE USED FOR LOAD TEST ON 60-INCH SEWER

Backfilling the trench was carried to the elevation of the points on the extrados halfway between the spring line and the crown. Clay derived from the excavation was used for the backfill, well compacted by tamping.

The Loading Saddle—After allowing the mortar joints 28 days to set, a cradle was built as shown in the drawing. The timbers are heavier than required for the loading, an excess quantity of heavy pieces being left over from previous work.

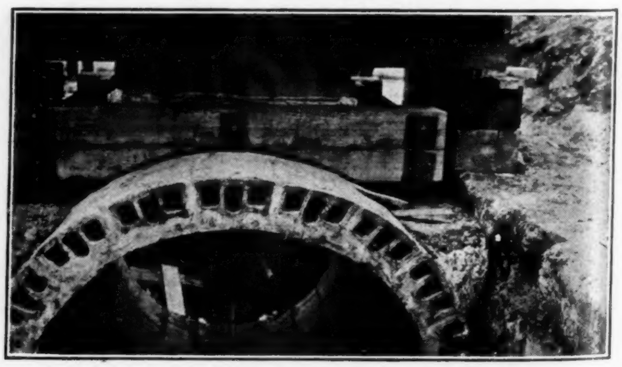
The sand cushion was entirely confined in canvas. The timber of the box which confines the sand at the sides and ends of the cushion was supported 1 inch above the sewer at the beginning of the test. After 10,000 pounds of pig iron had been loaded on the platform the pressure in the sand cushion maintained sufficient side friction to carry the box, and the box supports were removed. This left the entire weight, including box, sand, platform and pig iron, to be transmitted to the sewer through the sand cushion, no other part of the saddle structure being in contact with the sewer.

The Loading—A gang of seventeen men could wheel the pigs from a nearby pile, weigh them, and pass them up at a rate of from 15,000 pounds per hour in the beginning to 11,000 pounds per hour in the higher parts of the test load.

Blocks were placed on the ground surface at each side of the sewer to support the platform load. Wedges on top of these blocks were loosened after each 5,000 pounds of iron had been loaded on the platform, and the entire weight of the test load allowed to rest on the sewer. Deflections were measured while the wedges were loose, then the wedges tightened for the placing of the next increment of the test load.

Deflection Measurements—The displacements of the crown of the sewer were measured by noting the decreasing distance between the intrados at each end of the sewer and a tightly drawn wire running through the sewer and anchored to the ground at each end. This method did not indicate the decrease in vertical diameter.

Several independent measurements of the vertical diameter were taken. They indicated that the decrease in vertical diameter amounted to about an average of 60 per cent. of the deflec-



END VIEW OF TEST SEWER, WITH SADDLE IN PLACE

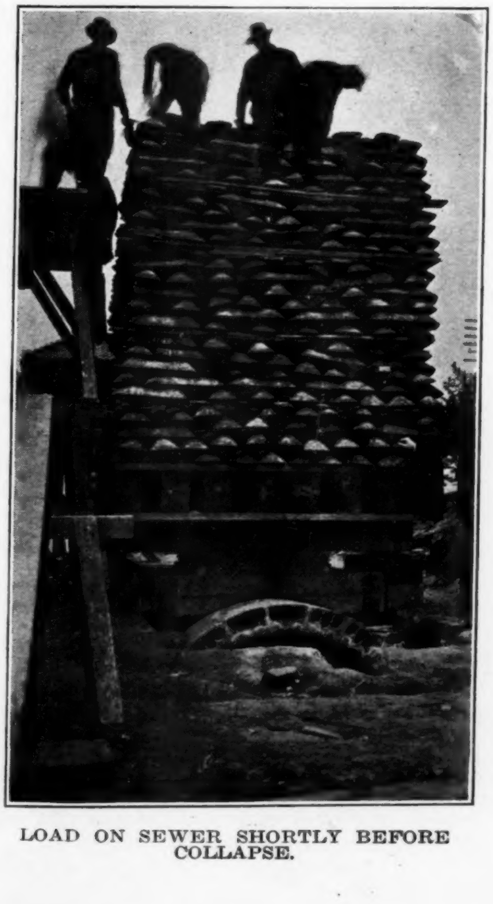
tion at the crown caused by the load, the remaining 40 per cent. being sinkage of the entire structure into the underlying clay. The crown displacements were read at first on an ordinary steel rule graduated to sixty-fourths of an inch, and later with a vernier caliper graduated to thousandths.

The increase in horizontal diameter was read with a rod and dial graduated to thousandths of an inch. All deflections were measured after each increment of 5,000 pounds in the loading.

Progress of Failure—The loading was started at 9 a. m. May 24, 1923. At 2.15 p. m. the first crack occurred at the intrados of the crown when the load amounted to 48,757 pounds and the deflection at both horizontal and vertical diameters amounted to about 3/64 of an inch. Cracks, in the extrados at mortar joints on both sides about half way between the spring line and the crown, developed under a load of 68,759 pounds.

At 128,976 pounds the crack in the intrados at the crown had opened to 3/32 inch in width, leaving the extrados edge of the block to carry the entire arch thrust. Under this load the webs of the blocks between the spring line blocks and the crown blocks sheared, closing the crack at the crown and distributing the thrust over the entire cross section at the crown.

Under 128,976 pounds the total elongation of the horizontal diameter amounted to 9/32 inch. The total sag at the crown under this load amounted to 3/8 inch, the initial measurement of the vertical diameter having been taken when the load amounted to 14,432 pounds.



LOAD ON SEWER SHORTLY BEFORE COLLAPSE.

The Collapse—When the load amounted to 128,976 pounds the sewer showed signs of distress and it was deemed too dangerous to continue the measurements. After one more increment of about 8,000 pounds the supporting wedges were again loosened at 2:30 p. m., May 25. Small pieces of mortar began to fall from the joints. Rapid cracking occurred. A few large pieces of the inner liner block dropped, and within 3 or 4 seconds the entire structure had collapsed. The laborer loosening the wedges had to exert himself to clear the pile, so quick was the failure. The point of initial rupture appeared to be on one side about half way between the spring line and the crown.

Summary of Test Load—The breaking load amounted to 9,800 pounds per square foot of sand cushion bearing. If, instead of being concentrated on the 14 square feet of sand cushion bearing, the load had been distributed over the entire top surface of the 8-foot test section of sewer from extrados to extrados at the spring line, the sewer could reasonably have been expected to carry a load much larger than 137,007 pounds.

However, calculating the total supporting power on a basis of 137,007 pounds over the projection of the entire top surface of 50 square feet gives a load of 2,740 pounds per square foot, which is more than sufficient for the most severe conditions in Paducah, where the maximum depth of 60-inch sewer will be 18 feet.

It might be added that the workmanship on the construction of the test section of sewer was better than the writer has ever seen under ordinary trench conditions, during a very limited experience with clay segment-block construction. Yet the test, in his opinion, was well balanced and entirely conclusive as to the strength of this sewer block.

Concrete Slabs for Bridge Floors

A bridge across the Connecticut river connecting South Hadley with Holyoke, Mass., showed maintenance charges for wooden floors so heavy that in 1922 the wood floor was replaced with one of concrete slabs, one-half the width of the roadway being left in service while the other half was being constructed.

The South Hadley end of the bridge consisted of two 160-foot spans. There was naturally a question as to whether these would be strong enough to hold the additional dead weight that a concrete floor would contribute, but investigation showed that the strength was there if the floor system were reinforced and additional floor beams put in so as to divide in half the original 16-foot floor beam spacing, the new beams being fastened by standard plate connections to hangers where the web members intersect midway between panel points. Stringers were placed on the floor beams 4 feet apart centers and these support the concrete slabs. The slabs were made 8 feet by 20 feet, weighing 8½ tons each, the longer dimension being placed across the roadway. In preparation for casting the slabs, careful measurements and levels of the floor system

were taken. The old floor beams extended above the tops of the stringers and the bridge is on a slight skew which rather complicated the construction. A plan of the floor system was made in duplicate at the yard where the slabs were cast, by means of steel shapes set in the same positions as the stringers and floor beams. Sand carefully levelled was used as the bottom of the mold and wooden arches were set on the sand to form arch recesses, the slabs being arched between points of support. Concrete was placed in the forms early in the fall of 1921 and the first slabs were not installed until the following May, so that there was ample time for curing of the concrete. A special frame was constructed on low, wide-tired wheels for carrying the 8½-ton slabs from the casting yard to the bridge, which frame was attached as a trailer to a 5-ton truck, which was assisted when necessary by a 10-ton Holt caterpillar tractor.

American Water Works Association Convention

Report of the forty-third annual convention, concluded from the June issue.

SUPERINTENDENTS' MEETINGS

The superintendents' meeting on Thursday afternoon opened with a discussion of Mr. Saville's paper on "Method of Paying for Waterworks Extensions." In discussing this, Mr. Saville called attention to the fact that overhead was included in the cost of the mains as assessed in Hartford and that this overhead averaged 23 per cent. of the total cost. A number of the members explained methods employed in their cities and states It was reported that a law is proposed in the state of Iowa under which the property will pay for the extensions, the money to be refunded when the owner connects with the mains and begins paying water rates. A number of members reported slight variations on the guarantee system whereby owners of property guarantee the company or department a sufficient income from the property along the line of the extension to pay reasonable annual charges thereon.

A paper entitled, "Clogging of Intakes by Fish," written by Leonard Metcalf, was read by F. A. Marston. The incident narrated occurred at Portland, Maine, where Lake Sebago is used as the source of supply. From December 5th of last year to March 15th of this year fish were found to be very troublesome, collecting in great numbers on the screens. This became intensified just before storms, even during the winter when there was thick ice and snow on the lake. At such times it was necessary to keep men with fish nets baling the fish from in front of the screen all night and clean the screens frequently. Inquiry was made of piscatorial authorities and it was learned that the fish were American smelt or graybacks which presumably came up into Lake Sebago to spawn, it being the practice of this fish to run up from salt water into fresh and remain two or three days and then return to salt water, the spawning season being at about the time when these fish were troublesome. The author believed that where fish were abundant it was advisable, in order to prevent their being drawn into the screen, to maintain a velocity of approach at the screen of not to exceed 0.5 of a foot per second. Several members endeavored to match this fish story. New Bedford had had trouble with herrings, smelt and eels when using lifting screens but not so much trouble with the present revolving screens. Arthur V. Ruggles told of endeavoring to keep eels out of an intake by placing over the intake a box about 6 feet cube filled with rocks, but the eels came through the rocks into the intake.

W. C. Hawley explained that the title of his paper, "Averaging Bills," was really a localism for estimating consumers' bills when the meter fails to register. His practice in most cases was to base the bill upon past consumption, not of one month alone but over a series of months or years, and for this purpose he found the plotting of past consumption on cross-section paper most valuable both in making the estimate and in satisfying the consumer as to the justness of it.

The "questions" previously published were then taken up in order, the first being the advisability of using flush hydrants. Mr. Gwinn stated that he had sometime ago taken out a number that had been used in his city, and S. H. Taylor stated that the Fire Underwriters had penalized New Bedford for the flush hydrants which it had and they had all been removed.

The question was raised as to the advisability of laying 4-inch laterals in sparsely settled districts. Mr. Taylor told of one instance where a long line of 4-inch pipe and a 4-inch hydrant had been laid, and 250 pounds pressure before the hydrant was opened was reduced to 15 pounds at a 1⅛-inch nozzle at the end of a line of hose.

There was considerable discussion on the advisability of using 4-1/2-inch steamer connections on fire hydrants. Mr. Hawley questioned whether, with a fire pressure, say, of 125 pounds, a steamer connected to a 4-1/2-inch nozzle might not shake the hydrant off its connecting pipe. Pres. Cramer stated that where a steamer was connected to two 2-1/2-inch nozzles, this took more time than connecting to a 4-1/2-inch nozzle. N. M. R. Wilson said that large connections were entirely unnecessary, but that using a 4-1/2-inch suction hose with a 2-1/2x4-1/2 reducer connected to a 2-1/2-inch nozzle would give practically the same effect as connecting to a 4-1/2-inch nozzle, the smaller nozzle acting as the throat of a Venturi meter, and Mr. Brush coincided in this opinion. One member stated that the fire department in his city never uses the 4-1/2-inch connections, although the hydrants have them. J. W. McEvoy of Dubuque stated that in his city the 4-1/2-inch are used with all fires and give no trouble; and the same was reported by S. H. Taylor of New Bedford, Mass., and A. S. Holway of Oklahoma City, in which latter city there is a pressure of 125 pounds at the hydrant.

The question being raised why high pressure is necessary where steamers are used, G. E. Shoemaker of Waterloo, Iowa, stated that the fire chief of that city asks not to have the pressure raised during fires.

Concerning the question, "Who pays cost of meter repairs when damaged by hot water," Mr. Chester stated that the rules should require the consumer to pay. Frank A. Marston referred to a relief valve to prevent hot water backing into the meter, which valve is used as a hot water faucet and thus is prevented from corroding shut.

Discussing the question of the legal right to make more than one service charge on multi-family houses, Mr. Chester referred members to the New Jersey definition of "consumer," which had been commended by the Pennsylvania Public Service Commission and which answered the question. Mr. Holway recommended one service charge per meter.

In the evening Leonard A. Day presented the report of the committee on pumping station betterments and requested that oral and written discussions of the report be sent in to aid the committee in making next year's report. The report referred to the use of powdered coal, different types of boilers, etc. Mr. Day had tried pulverized fuel on a small scale and the results were not favorable, although they might be on a large scale. Another point discussed was the use of superheated steam for both reciprocating and turbine pumps.

William W. Brush, by means of slides and discussion of them, described the methods and records of water waste control in New York. Mr. Bohman said that in

Milwaukee curb cocks set by plumbers were found to be so poor and so many of them leaking that the furnishing and laying of them was taken over by the water department. E. S. Cole recommended separating the meter consumption of manufacturing plants and other large consumers from the total consumption, since the most variation was found in the former; which would leave the domestic consumption more nearly comparable, even when still coupled with unaccounted-for losses. Mr. Saville stated that tests made in Hartford showed 1-inch meters to be as accurate as ⅝-inch meters on all flows, contrary to common opinion. John Chambers of Louisville reported that an investigation of their distribution system showed only one joint leak of importance, but an enormous waste.

Mr. Brush requested all members who had figures on the subject to send to the committee records of night consumption and how much of this was manufacturing, day consumption, and a description of leak investigations made, with the results and what the investigation had cost. Concerning stopping leaks, he stated that additional water from the Croton supply cost New York 25c per million gallons, while the stopping of leaks in the distribution system during the past few years had averaged $3 per million gallons of leakage thus eliminated; and that therefore until additional water cost much more than at present it did not pay to stop underground leaks in New York City. D. M. Hanna of Windsor, Ontario, had used an electric leak locater with success, but found that it could not be used where there was any noise, even that of a rainstorm, and it therefore would not seem to be applicable to noisy city streets.

G. Gale Dixon presented the report of the committee on Physical Standards for Distribution Systems, of which there was no discussion.

J. M. Diven presented the report of the committee on Standardization of Services, in which he discussed the new prepared joints and threaded centrifugal pipe. The strength of lead pipe of different sizes and a more scientific adjustment of thickness to size and pressure was a subject that the committee is to investigate this year. Concerning the use of brass pipe, he stated that this was no more expensive than heavy lead pipe. The committee is now trying out copper pipe. Mr. Fuller reported that there has been renewal in England of interest in lead poisoning, although a greater or less number of cases seem to occur every year in that country, where there is a great deal of soft water.

The final report of the evening was that of the committee on Standard Specifications for Water Meters, C. M. Saville, chairman. This committee had co-operated with one of the New England Waterworks Association in preparing this joint report, which was published several weeks ago. The report was accepted and the committee continued and asked to give further study to the matter of registration.

FRIDAY SESSIONS

Friday morning's session of the superintendents' meeting was opened with a demonstration by Charles P. Hoover of the standard method of water softening, Mr. Hoover illustrating the chemical reactions by means of two large test tubes, one containing hard water and one with zero hardness, lime water and phenolphthalein. In discussing this subject it was stated that Newark, Ohio, has begun introducing carbon dioxide as a gas through filtros plates instead of in the ordinary manner. A similar process was just being started in Lansing, Michigan. At Flint, Michigan, it has been noticed that a flat taste followed the softening and a carbonator was installed for improving the taste. It was suggested by Mr. Hoover that the ideal process would be the collecting of the CO_2 gases given off in the burning of the lime and introducing these into the softened water to combine again with the lime, thus returning it to approximately its original chemical condition.

The use of a portable air compressor on a water works distribution system at Champaign, Illinois, was described by F. C. Amsbary, the manager of the water company. This was used chiefly for operating a tool for cutting out concrete and brick pavements in trenching for pipe lines and services. Before making the purchase, local contractors agreed to rent the machines, thus securing sufficient use to meet overhead costs. The compressor was mounted on a Ford truck. Shortly after receiving it it was used in cutting a narrow trench for a conduit. Contractors cutting a trench 121 feet long, along one side of the street, using hand labor, found the cost to be 27 cents a running foot, while a trench of the same length on the opposite side of the street was cut by means of the air compressor at a cost 9¼ cents per foot. Twenty-one lineal feet of hard concrete was cut out in 20 minutes by means of the compressor, while it would have required two men 2 hours by hand. The compressor cost $1,087, the truck cost $558, $44.50 was paid for freight, hauling, etc., and the total cost, ready for service, was $1,723. The compressor was also used for operating a tamper on backfilling, a pneumatic spade, and probably will be used for calking and other tools.

It was announced at this session that Prof. George C. Whipple had retired as a member of the Standardization Council and that his successor was W. W. De Berard.

Additional superintendents questions were taken up, the first being one asking for experiences with flush-flow water closets, especially the size of service pipe required and used. Two members reported using ⅝-inch service pipe, but placing in the basement a 40-gallon boiler which operated as an air-pressure tank, a larger pipe being carried from the bottom of this boiler to the flush valve. Provision was made for recharging air into the tank by drawing off the water by means of a stop cock, while air was admitted through another stop cock in the top of the tank. Mr. Hawley stated an instance where 20 closets in a school house using flush valves were fed from a 1-inch line by means of a tank such as this. Mr. Ackerman had used a 40-gallon hot water tank to cushion the hammer from hydraulic elevators and found that in this case the air in the tank was absorbed within 24 hours. C. R. McFarland suggested that added fire risk would be caused by the use of 1½-inch or 2-inch service pipes as compared to the customary ⅝-inch should they be broken off during a fire. A. S. Holway stated that in Oklahoma City consumers could have any size of service pipe they asked for, but a service charge was made, regulated by the size of pipe, and the same idea was expressed by Mr. Chester. As to the importance of the question to water works superintendents, a representative of a company manufacturing these valves, stated that 30% of the closet flushers installed last year used these flush valves. As an advantage offsetting the large size pipe, he stated that they used less water per flush than did the ordinary tank.

Concerning the question of keeping the records of the location of water services, Mr. Brush stated that in New York it is required that they be laid perpendicular to the street line and the location from the nearest street corner be determined and recorded to the nearest inch. J. E. Gibson stated that he had used an electric pipe locator very successfully for locating services.

Answering the question as to the control of lawn sprinklers used on a flat rate basis, Mr. Chester apparently expressed the sentiment of the convention that the only proper plan was by putting them on meter basis.

Concerning the laying of water mains or services in the same trench as sewer pipes, several members reported doing so under certain conditions and with precautions. Among these was Mr. Brush of New York; A. V. Ruggles of Cleveland, and others. Mr. Ruggles stated that they were not laid in the same trench unless this was in rock, when the water pipe was laid on a ledge cut into the side of the trench. Mr. Folwell had laid them in a deep rock sewer trench by building piers of lean concrete 12 feet apart against the side of the trench as supports immediately behind the bell of each pipe.

J. N. Chester then read a paper entitled "Leakage and Unaccounted for Water," in which he emphasized the

importance of locating leaks and reducing to a minimum the unaccounted for water, stating that leaks could ordinarily be located at comparatively small expense of money and time. He had found especially useful the pitometer and the geophone. By these means a leak had been located at Piedmont, West Virginia, in two nights and he believed that almost any leak, no matter how difficult its location, could be discovered in that time. As for unaccounted for water, records seem to indicate that under-registrations of service meters of 25% to 60% was by no means uncommon. Incidentally, he stated that, contrary to more or less popular belief, meters could over-register by reason of deposits formed on the inside of the chamber of the meter which would more than offset the slowing up of the operation of the meter because of these deposits. A. S. Holway told of 44% of unaccounted for water having been reduced to 26% by proper investigation, the loss having been due largely to under-registration of meters. Mr. Cramer spoke of one instance in which the water works authorities were sure that the distribution system was in perfect condition with no appreciable leakage, and yet investigation showed 740,000 gallons a day leaking into a sewer.

By means of lantern slides, Chetwood Smith showed startling results from the explosion of kitchen boilers due to failure to turn off the gas heaters connected thereto and the failure of relief valves to operate. These illustrations showed kitchens and adjoining rooms completely wrecked by such explosions. The only safeguard (where there are check-valves) would be some means of insuring that the relief valve operated occasionally so as to prevent the pipe clogging or the valve seat corroding in place, or else the use of a valve with a seat so large that moderate pressure would overcome such corrosion. E. T. Crane expressed the opinion of several of the members in stating that he believed it much better to omit the check-valve altogether, it being much preferable to pay for repairing an occasional meter burnt out by the backing up of hot water than to run the risk of such explosions.

Charles Fox of the Pennsylvania Water Company of Wilkensburg showed by slides the cards used in the meter card index system of that company, these forms having been in use since 1910.

The session concluded with a paper by J. Walter Ackerman entitled "The Effect of Industrial Use of Water on Total Consumption."

The afternoon and concluding session of the convention opened with a paper by Donald H. Maxwell, entitled "The Water Works Coal Pile." Messrs. Toyne, Bohman and Denman discussed this paper. A paper entitled, "A Possible Source of Income for Small Plants," by Howard Dill, was read by Mr. Gwinn. The final paper by John W. Toyne entitled "The Use of Fire Hydrants for Purposes Other Than for Extinguishing Fires," was followed by considerable discussion, largely as to the methods of preventing such use or rather misuse. A number of the members believed that while prevention was desirable, the most practicable result obtainable was a careful regulation of use by means of permits issued by the waterworks. Many of the members, however, cited instances in their own cities of unfortunate and sometimes disastrous results from the use of fire hydrants by contractors.

Following these papers a discussion of various subjects was carried on by the superintendents, these subjects including "Treatment with Copper Sulphate to Destroy Algae," Messrs. Fuller, Cramer, Chambers, Gibson, Crane, Milne and others discussing it.

A poll was taken to determine what states require a license for filter operators, and representatives from Pennsylvania, Iowa, Kentucky, Ohio and Virginia, as well as Canada, reported that no licenses were required in their states. While Ohio requires no license, it has a strong association of filter operators which meets once a year. New Jersey requires operators to have licenses. Texas also requires licenses and conducts a school for filter operators.

The subject of "Maintaining Water Services and Payment for the Same" was discussed by Messrs. Brockway, Bulkeley, Bunks, Chester, Cramer and Davis. The subject of "Private Fire Protection Services" was discussed by Messrs. Bohman, Chester, Gwinn and others; following which the convention adjourned.

Refuse Collection in Waltham

The collection of garbage in Waltham, Mass., was taken over by the city forces on the first of May, 1922, and the procedure followed is described as follows by George C. Brehm, Director of Public Works, in his annual report for that year:

"A central dumping platform was constructed of concrete at the water works yard. This dumping platform is built entirely of concrete and supplied with water and sewer connections. It is thoroughly washed at least twice a day.

"The city is divided into seven routes. Six routes are in the built-up section of the city and are handled by steel sanitary dump carts, which hold 54 cubic feet of garbage. A small truck with a steel, sanitary, 1-yard body is used in the outlying districts. These carts and trucks make two trips a day. The garbage is brought to the dumping platform and dumped through the scuttle hole into the trucks backed under the platform. As soon as the carts are emptied they are thoroughly washed and cleaned with a hose before leaving the yard for the second load. The routes are so laid out that two collections per week are made at each house. In the business sections a collection is made every day.

"The garbage collected is sold on bids and was this year awarded to Thomas F. Bergin at a contract price of $4,200 per annum, delivered into his trucks at our yard. The amount of garbage collected each month is given in the following table:"

May	625½	cord feet
June	603	" "
July	451	" "
August	860½	" "
September	621½	" "
October	736	" "
November	650	" "
December	682	" "
January, 1923	647	" "

The dumping platform consisted of a concrete bridge or under-pass just high and wide enough to permit a truck to pass under it, with a ramp or inclined approach leading to each end.

During the year 24,388 cubic yards of ashes were collected using an autocar, 4 bottom-dump carts and 4 double sleds (the last for 22⅝ days only.) A Kelly-Springfield truck was used one day. The cost was $19,256, of which $12,847 was for labor, $5,465 was for teams and trucks, the balance for equipment repairs, new equipment and vacations.

Titles for Automobiles in Pennsylvania

A law just signed by the governor of Pennsylvania makes it illegal to own or operate a car in that state after November 25, 1923, without a certificate of title, and no 1924 license tags can be obtained without such certificate. Certificate of title is good for the life of the car.

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A. PRESCOTT FOLWELL, Editor

CONTENTS

Economy of Trenching Machinery

Of all the cities, large and small, replying to the questionnaire sent out by us last month, about one-third report the use of excavating machinery in sewer trenching. As a number of the cities laid only a few hundred feet of sewer, for which the use of a machine would not be economical, it appears that trenching machinery was used on fully a half of those having any amount of sewer on hand. Information concerning the use of such appliances in several cities will be found on pages 222, 223 and 236 of this issue.

One of the engineers who gave some details concerning operation states that his excavator does the work of 30 to 40 pick-and-shovel men, where the conditions are ideal. In another city, where large stones and ledge rock were encountered and other conditions were far from favorable, the showing is not nearly so good, but even here the city engineer reports that "the work is being done far cheaper than it could be accomplished by hand."

Taking the first case, and assuming labor at $4 a day, excavator operator at $8, gas and oil at $5 a day, maintenance and repairs of machine at $1,000 a year, machine operated 150 days a year but crew on the job and paid for 200 days, and depreciation at 15% and interest at 5% on a cost of $12,000; we have the cost for 150 days' work as $7,350 by machine; while 30 men would cost $18,000, and 40 men $24,000, showing a profit of $10,650 to $16,650 a year under ideal conditions.

It must not be overlooked, however, that there are some conditions under which the use of a machine would be uneconomical; (although there are other advantages of machine excavating, such as independence of labor and minimized blocking of streets, which may outweigh absence of economy). Numerous pipes crossing the trench, quicksand, boulders, or limited number of working days, may so cut down the amount of work done in a year that the fixed cost of $6,000 to $7,000 can not be met by the operating profits. But the advantages under most conditions are so great that the use of excavators should be considered where any but the smallest jobs are being figured on.

Salaries in Federal Scientific Positions

Elsewhere in this issue we give notice of Civil Service examinations to be held for a number of positions in the Federal service, to be filled by engineers, physicists or others with scientific training. We would call especial attention to the salaries offered. Take, for instance, that of Junior Aid, Grade One. To fill this position the applicant must have graduated from a four-year high-school course, which included at least one year's work in physics, chemistry and manual training. This young man of eighteen or nineteen who has successfully completed the high-school course will be paid the enormous salary of $540 a year, plus an additional $240 a year generously granted by Congress to allow for the present high cost of living. The total will then amount to about $2.50 a day. Laborers are now receiving nearly double this amount and the basic wages for plasterers and others in the building trade are more than four times this.

Going up almost to the top of the list, we find that an engineer who has graduated in civil engineering from a school of recognized standing and has had additional training and experience may receive $1,740 a year, or about $5.60 a day, or about half the amount being paid to mechanics in the building trades.

When we take into consideration the cost of a four-year course in an engineering school, including the loss of wages meantime, and the greater respon-

sibility imposed upon an engineer, to say nothing of the other qualifications that are essential and which are generally considered entitled to higher pay than that of a mechanic, who carries out minor details under the orders of his superiors and in doing so utilizes a skill which can be acquired in comparatively few months, the discrepancy between the amounts paid to mechanics and those allowed by the Federal Government certainly cannot be considered as encouraging men possessing any ambition to enter the technical departments of our Government.

Advice by State Engineers

A paragraph in the report for 1922 of the Maryland Bureau of Sanitary Engineering reminds us of the discussion recently held by members of the American Association of Engineers and others concerning the giving of engineering advice and services by men in the employ of state or federal governments.

This paragraph is as follows: "The engineering services of the Bureau are available to all state institutions on work similar to the above" (advice, preparing plans and specifications, and supervising construction of sewerage and sewage treatment systems) "upon authorization of the governor or the legislature. As no appropriation is available for these added duties, it has been the policy of the Bureau to charge for the preparation of contracts, plans and specifications to the extent of the actual cost for the time and expenses of the men employed on the work, plus 15% of the amount of personal services of the men engaged, to cover use of equipment, blueprinting, stenographic services and engineering supplies. It is believed from past experience that this work can be carried on with less cost to the state if all improvements of a sanitary nature are developed under the supervision of the Bureau."

English Practice vs. American

Three items appearing in a recent issue of an English engineering paper would seem to warrant the opinion that England is considerably behind the United States in some respects. The contractor laying a large water main for the City of Manchester and employing a large force of men thereon has made no provision for housing these men, although the work is far removed from any city where they can find accommodations. As a result of this, it is reported that the men are sleeping at night in the water pipes and, in response to a protest, the contractors have agreed to contribute $700 towards the cost of converting an old factory into sleeping quarters for the men. The periodical refers in this connection to "the foresight shown by American engineers and contractors in providing temporary housing accommodation for workmen engaged on large contracts far removed from a town or city."

The second item refers to the fact that the police of the city of London have recently been supplied with dry battery lamps for use at night to take the place of bullseye lanterns burning oil which they have used heretofore. As the periodical states: "Certainly it is cleaner and should prove more economical." We would think it would also be much more convenient than the carrying of an oil lantern on night duty.

The third item refers to the numbering of houses, and in this connection says that in America "an entirely new method has been introduced, which consists in placing the number on the side of the curb immediately opposite the house. . . . There are two questions which one would like answered, namely: What is done in wet weather when the curbs are freely spattered by mud and the numbers hidden? and, How are the numbers distinguished at night?" In answer we would inform the English municipal officials that it is not the practice in this country to allow the streets to get so dirty that the curbs are coated with mud splashed from the gutters; and as for seeing the numbers at night, the answer is probably that the American streets are much better lighted than those of English communities. Incidentally we might state that the method is by no means an entirely new one, but was described in this journal about ten years ago and possibly had been in more or less common practice in certain sections of the country for some years prior to that.

It is sometimes claimed that English municipal governments are much freer from graft than are American ones, if in fact graft in its extreme form can be found there at all. We find, however, in an English paper the statement that it is rumored that the "technical staff of a certain borough council not 100 miles from London have reduced the receipt of baksheesh to a fine going even to the extent of appointing an official receiver, who receives on behalf of his colleagues and periodically shares out." It is intimated that if the contractors do not contribute as liberally as desired, it will result in claims of bad workmanship or other unfavorable reports, or the boycott of appliances or materials involved.

United States Civil Service Examinations

Examinations for the following positions are announced by the U. S. Civil Service Commission. Full information and blanks may be obtained from the Commission at Washington, D. C., or at the postoffice or custom house in any city:

Irrigation engineer, $2,400 to $3,600 or over a year.

Civil engineer, $2,400 to $3,600 or over.

Assistant irrigation engineer, $1,600 to $2,280.

Assistant civil engineer, $1,500 to $2,280.

Design draftsman at the naval operating base in Hawaii, $6.80 a day and $8.80 a day. (Experience in designing steel, concrete, reinforced concrete and timber structures for buildings, wharves, etc., essential).

Junior engineer, junior physicist and junior technologist in the Bureau of Standards, $1,200 to $1,500 a year.

Laboratory assistant, senior grade, in Bureau of Standards, $1,200 to $1,380 a year.

Laboratory assistant, junior grade, in the Bureau of Standards, $1,000 a year.

Senior aid in Bureau of Standards, $900 a year.

Junior aid, grade one, Bureau of Standards, $540 a year.

Junior aid, grade two, Bureau of Standards, $720 to $840 a year.

In addition to the above salaries, an increase of $20 a month has been granted by Congress to all who receive a salary of $2,500 a year or less.

Bates Test Road

The following letter from Clifford Older, chief highway engineer of Illinois, was received several weeks ago, and was submitted to Mr. Brown for reply, as is our practice. This reply was in turn submitted to Mr. Older. Delay in publishing the letters has been due to the time consumed in this three-cornered correspondence.

May 10, 1923.

A. Prescott Folwell,
Editor, Public Works,
New York.

Dear Sir:

I have read with interest and much surprise the article by Charles Carroll Brown in the April, 1923, issue of Public Works, and purporting to be a discussion of the tests made on the Bates experimental highway. This article contains gross misstatements concerning the drainage of certain portions of the Test Road. The following are quotations from this article:

"*Macadam Bases Under Brick.* The sections of brick pavements and one of asphaltic concrete on macadam base were located near a culvert under the road, where, on account of the lack of drainage of the road, the water gathered, and, as a consequence, these sections were for much of the time soaked with water." . . .

"That the forcing of the macadam into the subgrade, softened by water, was the cause of the rutting of the brick pavements on macadam base was also evident, without reference to thickness of base. The sections with 8" macadam base were farther down the slope toward the culvert than those with 4" base."

The fact of the matter is that there is not now, and never was, a culvert under the road within one-quarter of a mile of the brick section having an 8" macadam base. The nearest culvert in the Bates Road to this section is located 1,500 feet west of the west end of the section mentioned. Nor is the statement true that the sections with 8" macadam base were farther down the slope toward the culvert than those with 4" base. As a matter of fact the slope of this part of the road is toward the east, and the 4" macadam base sections are east of the 8" macadam base sections, the drainage being from a point several hundred feet west of the 8" macadam base sections, past this section, the 4" macadam base sections, and beyond the end of the road to a natural drainage channel 400 or 500 feet east of the beginning of the road.

I would like to call attention also to the following further quotations from the same article:

"The same would be true of the rigid or semi-rigid wearing surfaces on macadam bases. Such bases might themselves be expected to give way on so poor foundation as they had, emphasized as this was by the extra amount of water almost always present on the sections of the highway in which most of them were located." . . .

"The writer's observation showed the portion of the section most nearly out of water to be in fair condition for light traffic." . . .

"The lack of the same action in the macadam under the brick sections and the lower asphaltic concrete sections is definitely due to the backing up of the water on account of the total absence of drainage at that point." . . .

"The 8" basese were in the water and the brick pavements nearest out of the water were 3" blocks on 4" macadam base."

The author states that this last quotation applies to Sections 1 to 5 inclusive.

These last quoted statements are as misleading and as utterly unfounded as those relating to the nearness of a culvert to the macadam base brick sections. Throughout the entire test a ditch was maintained on each side of the road having uniform slopes to the outlet. The bottom of these ditches at the highest point was 30" below the crown of the finished pavement, and at no time since the road has been built has water stood or flowed in side ditches at an elevation greater than 18" below the crown of the finished pavement at any point; nor at any time has the water stood or flowed in the side ditches at an elevation as high as 18" below the crown of the finished roadway for more than a few hours at a time. The statement therefore that "the 8" bases were in the water" is absurd.

The first increment of truck traffic tests was started on March 30, 1922. On March 25 there was a rainfall of .17 of an inch, and the same amount on March 26. On March 27 soil samples were taken from underneath each test section of the entire road, and this was done every week thereafter. Those taken from underneath the brick section having the 8" macadam base showed a moisture content of 31% of the dry weight of the soil. Those taken from underneath the rigid pavement slabs on the same date ranged in moisture content from 31.7% to 36.5% of the dry weight of the soil. Approximately the same relative moisture content applied until the sampling from the subgrade under the brick-macadam base sections was abandoned because of the destruction of these sections. These figures indicate clearly that the moisture content of the subgrade soil was certainly not higher than that of other sections at the same time.

The accuracy of the remainder of the statements in Mr. Brown's article may properly be judged by these facts.

Very truly yours,

Clifford Older,
Chief Highway Engineer.

A. Prescott Folwell,
Editor, Public Works,
New York City.

Dear Sir:

Thank you for sending me a copy of Mr. Older's letter.

To reverse the order of his comments: He does not grasp the point which I am trying to make regarding water in the foundation of a road.

It really makes an almost inappreciable difference whether the water in the ditch is 18 inches below the crown of the finished pavement (which is 5 inches below the bottom of the 8-inch macadam base) or 30 inches below if the water is standing in the ditch or the sub-soil. The water will rise by capillary action in the clay soil and gather at convenient places. Small excavations along the edge of slabs and small channels to drain them indicated, at the inspection made in October, 1922, that water had been found in sufficient quantities to be drained away at places at a higher elevation than the low ground, the description of which Mr. Older objects to.

Wet sub-soil is a serious detriment to pavements, and the emphasis by progressive engineers is now laid on getting rid of it. This may be difficult in Illinois, but there are not many miles where it is impossible. It is largely a question of expense. The cost of the Bates Experimental Road may be justified if the cost of building and maintaining roads of various kinds on such a foundation can be estimated. The cost of constructing and maintaining proper drainage can then be compared and the more economical course chosen. My only criticism of the Bates experiment is that it did not include some bases which have been recognized for several years as improvements over some of those used.

The thesis of my article in the April number was that the macadam or broken-stone base showed up better as a base for asphaltic concrete, brick, and concrete than the others used, all three wearing surfaces on comparatively light bases standing up in very satisfactory relation to the excessively heavy reinforced concrete sections. Explanation of the exceptions to this statement was attempted by calling attention to the fact that these weaker sections were in lower ground than the rest so that the full effect of the macadam base was not obtained.

The reason for the excellence of the broken-stone base was developed to be the greater size of the voids in the layer, which stopped capillary action and kept water away from the bottom of the wearing surface. This macadam

layer acts as a distributor of the pressure from the wearing surface, and, as indicated by the successful sections, increases the durability of those sections and their ability to carry heavy loads.

It is evident that if water is permitted to gather in this macadam base the effect of its open structure will be lost and that it will be pressed down into the clay or earth foundation, which would be softened by the same water. Hence the necessity for good drainage of the macadam base.

I beg your pardon and Mr. Older's for being so blind in working out the April article as to make it difficult to follow. When I read it in type it did not seem as clear as was hoped; perhaps because it was made as brief as possible and stated the facts. This thesis was worked out partially in the article on bituminous sections in PUBLIC WORKS for December, and possibly Mr. Older will be interested in reading that.

This is not the place to carry this argument into all its details, and so it is stopped here at the risk of again being misunderstood.

As to Mr. Older's questions of misleading statements:

I first visited the Bates Road about Christmas, 1920, when it was under construction, with Mr. Fleming of the Illinois Highway Department. I do not have the profile of the road at hand, but it is my recollection that a culvert was located in Section 5 or 6 which at that time had no outlet, as stated in articles in PUBLIC WORKS in February, 1921. It served simply to equalize the height of water in the ditches on the two sides of the road. Possibly this culvert has been closed. My notes of my visit in October, 1922, show the same low spot. If there were no outlet to water gathering in this low spot it is evident that water would rise in the ditches and even higher until it reached the level of some place through which it could overflow over the surface of the ground. On account of the low rate of absorption of water by the characteristic Illinois soil this water must evaporate before it disappears. Possibly some outlet for this low spot has been devised. It was not conspicuous enough for me to notice it on my last visit. The pavement sections in the vicinity gave clear indications of more trouble with water than others farther up. This is my justification for all the statements that Mr. Older classes as misleading. If the drainage of this low spot has been effected I shall be more than glad to modify the statements complained of as much as may be necessary. I hope to visit the road again after the test now in progress is completed, and shall pay special attention to this point.

As to Mr. Older's question of fact:

I have in hand Test Road Bulletin No. 1, dated April 10, 1922, which contains "Descriptive Data on Bates Experimental Road," prepared by Clifford Older, Chief Highway Engineer. In this I find "Detailed Description by Sections." Beginning at the east end the first five sections are of brick on macadam base and each 100 feet long. Sections 1, 2 and 3 are stated to have a base course thickness of 4 inches of crushed limestone, and Sections 4 and 5 have 8 inches base course thickness of crushed limestone. I do not find any other brick sections with macadam base.

Sections 23 to 39 have crushed limestone aggregate in the base, but this is definitely stated in the headings of the descriptions of these sections to be portland cement concrete base. Section 58 is of 4-inch portland cement concrete on 4-inch rolled stone base. This section stood better than heavier sections without rolled stone base, and was noted in my April article as one of the evidences in favor of the value of the macadam base. In one of the bulletins descriptive of the tests the good condition of this section was suspected to be on account of better drainage than that of other sections. My own comment in effect was that the macadam base is a better explanation (on account of the cutting off of capillary action) than luck in placing this particular section in a particularly dry 100 feet, not possible to select purposely except by detailed borings to determine water content of soil. Possibly Mr. Older has confused one of these sections — 23-39 or 58 — and called it 8-inch macadam. If he is right I shall be glad to have the number and full description of the section. At any rate I have no notes of such a section and no brick sections on macadam base except 1 to 5, which were referred to in my article. And the lowest spot is on Section 5 or 6, with the road sloping up to east and to west therefrom.

Yours very truly,

Charles C. Brown.

Los Angeles' Outfall Sewer

First steps being taken in the construction of twelve million dollar project. Novel features of design.

Bids were received on July 9th for four sections of a new outfall sewer for Los Angeles, California, known as the "North Outfall Sewer," and on July 30th bids will be received for the ocean end of the outfall at Hyperion. A bond issue of $12,000,000 has been authorized to pay for the outfall. The sewer is divided into fourteen sections, section 1 being the ocean end, with a length of 5,723 feet, most of it under water; sections 2 and 3 are the treatment plant, and the remaining eleven sections, totalling 81,377 feet, lead from the treatment plant to the city of Los Angeles proper. The sections being let this month include the submarine outfall at one end of the line and the four sections at the other end thereof.

The ocean end will consist of 429 12-foot lengths of pipe having an internal diameter of 84 inches and 46 12-foot lengths having an internal diameter of 60 inches. Alternate proposals are asked for Class D cast iron pipe of the standard bell and spigot type and for reinforced concrete pipe having special bell and spigot joints. The 84-inch pipe will extend 5,145 feet from the shore into 50 feet of water and here will divide into two 60-inch branches at right angles to each other and making 45 degrees with the main line, which will extend 283 feet further to a point where the depth is approximately 56 feet. At the outlet ends special fittings will be provided so that the sewage will discharge upward at a point about 4 feet above the ocean bottom. The pipe will be laid just below the ocean bottom which, according to the borings, consists almost entirely of sand. Piling will be required for a distance of 700 feet through the surf, and concrete aprons around each of the two special outlets. This contract will be for installation only, the city furnishing the pipe at the siding at Hyperion.

The submarine reinforced concrete pipe is to be composed of concrete mixed 1 cement, 1½ sand and 2½ crushed stone or gravel. The steel reinforcement will consist of two cages of 5/16 inches round wire; for 5-foot pipe one cage is 64 inches and the other 71⅜ inches diameter, and for the 7-foot pipe one is 89 inches and the other 86⅜ inches diameter. In addition to the circumferential reinforcement, there will be longitudinal reinforcement consisting of twelve ¾-inch bars placed just inside the outer cage and just outside the inner cage of the circumferential reinforcement. The pipes are to be made in 12-foot lengths with bell and spigot joints, allowing a ¾-inch annular space at the

joint, with a depth of bell of 7 inches for the 60-inch pipe and 8 inches for the 84-inch pipe. The concrete for the 60-inch pipe will be 8 inches thick and for the 84-inch 9 inches.

Section 11 consists of 5,130 feet of 7-foot 6-inch and 6-foot 3-inch sewer; section 12, 5,414 feet of 6-foot 3-inch and 5-foot 3-inch sewer; section 13, 9,802 feet of 4-foot 9-inch, 5-foot 3-inch and 6-foot 3-inch sewer; and section 14, 8,914 feet of 6-foot 3-inch sewer. Some of the other sections will be in tunnel, this including part of sections 4, 6 and 7, which tunnel is to be 13 feet by 12 feet.

In constructing the sewers, the city will use one of three types of construction, contractors being requested to bid upon all three. These types consist of: first, brick-concrete construction—a concrete invert with a brick arch and vitrified brick lining for the entire circumference; second, block construction, consisting of Ferguson segment block with a concrete base; third, pre-cast reinforced concrete pipe with vitrified clay lining, also resting on a concrete base. The city will furnish free of cost to the contractor, along the lines of work, all the brick, segment block and pre-cast concrete pipe required, separate contracts being made for the furnishing of these materials.

The pre-cast concrete pipe, from 4 feet 9 inches to 8 feet 6 inches internal diameter, is to be of concrete pipe reinforced with steel and lined with vitrified clay block integral with the concrete aggregate of the pipe. The concrete is to be mixed 1 cement, 2 sand and 4 crushed rock or screened gravel passing a 1½-inch screen. The clay lining blocks are of such widths that there will be 19 in the 57-inch pipe, 20 in the 60-inch, etc., up to 36 in 108-inch pipe. These blocks are 1 inch thick and 18 inches long, and at each side have a fan-shaped projection extending into the concrete and producing a dovetailed joint. The width between the vitrified clay lining blocks is not to exceed ¼-inch, except that the closing joint may equal ¾-inch, but all joints shall approximate ⅛-inch as nearly as practicable. The concrete pipe, including the blocks, varies in thickness from 5¾ inches for the 57-inch up to 10 inches for the 108-inch, increasing by increments of ¼-inch for each 3 inches in diameter. The reinforcement will be of spiral steel 5/16-inch, ⅜-inch and 7/16-inch in diameter according to the size, while the number of coils per linear foot vary from 3 to 5. The reinforcement is to be so placed in the concrete as to be ¾-inch from the clay lining blocks at the top and bottom and 1-inch from the outer surface on the horizontal diameter. This pipe, like the Ferguson segment block, is to rest in a cradle of 1:3:5 concrete 9 inches thick at the invert and with the distance between the outside vertical faces equal to the outside diameter of the sewer.

The brick-concrete sewer consists of a cradle with flat bottom and vertical outer faces, 2 feet 2 inches wider than the inside diameter of the sewer and extending up to the horizontal diameter thereof. On this is built an arch of common sewer brick, two bricks thick for 30 degrees above the horizontal diameter and one brick for the remaining distance; both arch and concrete cradle to be lined with a ring of vitrified sewer brick 3¾ inches thick.

The city asks for bids for 26,000,000 sewer brick and 16,000,000 vitrified brick for the construction of sewers of this type, should it be decided upon. For the arch brick a compression test is required of not less than 2,000 pounds per square inch, and for the interior lining brick an absorption limit of 4% of the dry weight of the brick when immersed in water for 24 hours.

Hill to Hill Bridge

Concrete arch highway structure, 6,000 feet long, 60 feet wide and 60 feet high, will afford a high-level connection between important business and residential sections of Bethlehem, Pennsylvania. It has several ramps, serving low-level streets and providing seven entrances. It will cost $2,568,000, and is now about three-quarters finished and will be completed in 1924.

By Frank W. Skinner

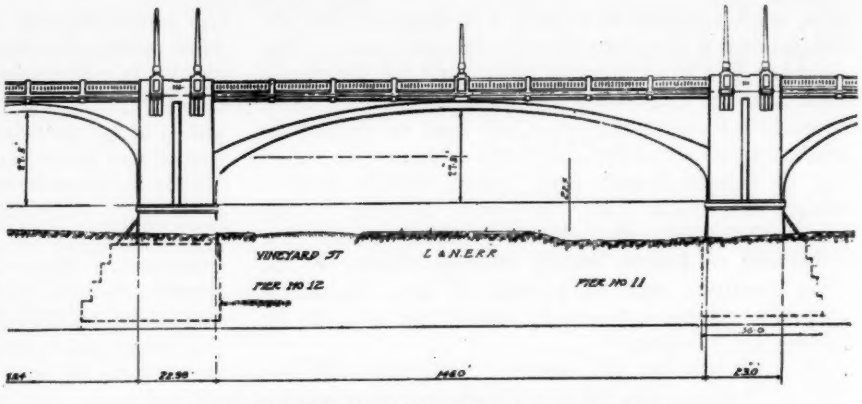
The construction of the hill-to-hill bridge in Bethlehem, Pa., over the Lehigh river, the Monocacy creek, several lines of railroad tracks, and a number of streets is a difficult engineering achievement of considerable commercial and industrial importance that has enlisted county, state, municipal and individual co-operation and will provide an unusually handsome and valuable improvement for the city and adjacent country. The problems occasioned by deep foundations encountering great quantities of water, and the simultaneous rapid construction of large masses of concrete in different positions and at different levels have been solved by the installation of $300,000 worth of construction equipment, which will mix and handle 100,000 yards of concrete, using about 160,000 barrels of Pennsylvania portland cement.

It connects the three principal, widely separated portions of the present city of Bethlehem with 70,000 inhabitants, providing easy and direct

communication, previously unavailable, between the original city of Bethlehem, South Bethlehem and West Bethlehem on opposite sides of the river and creek without ascending and descending steep grades, makes a common thoroughfare for the different sections, and provides convenient access to the principal railroad stations.

In response to a popular petition, the Bureau of Engineering of the Public Service Commission of the Commonwealth of Pennsylvania conferred, in 1915, with representatives of the citizens' committee and the council and with engineers of various interested railroads, after which the inadequate public bonds available were increased $1,119,899 by subscriptions from C. M. Schwab and other individuals and by contributions from the Bethlehem Steel Company, Northhampton County, Lehigh County, Lehigh Valley Transit Company, South Bethlehem Borough, Bethlehem Borough, and the Lehigh & New England, the Philadelphia & Reading, the Lehigh Valley and the Central Railroad companies.

The bridge is being built under the direction of the Public Service Commission, Dr. F. Herbert Snow, Chief of the Bureau of Engineering, acting through the local organization known as the Bethlehem Bridge Commission, of which Archibald Johnston is chairman and Clarence W. Hudson, engineer. The complete design of the structure was prepared in 1917-18, but the World War prevented its immediate execution. Bids for it were received in 1920, but, not being favorable, were rejected and a revised design was prepared in 1920-21, bids for which were opened June 30th, 1921, and the work was awarded to Rodgers & Hagerty, Inc., New York.

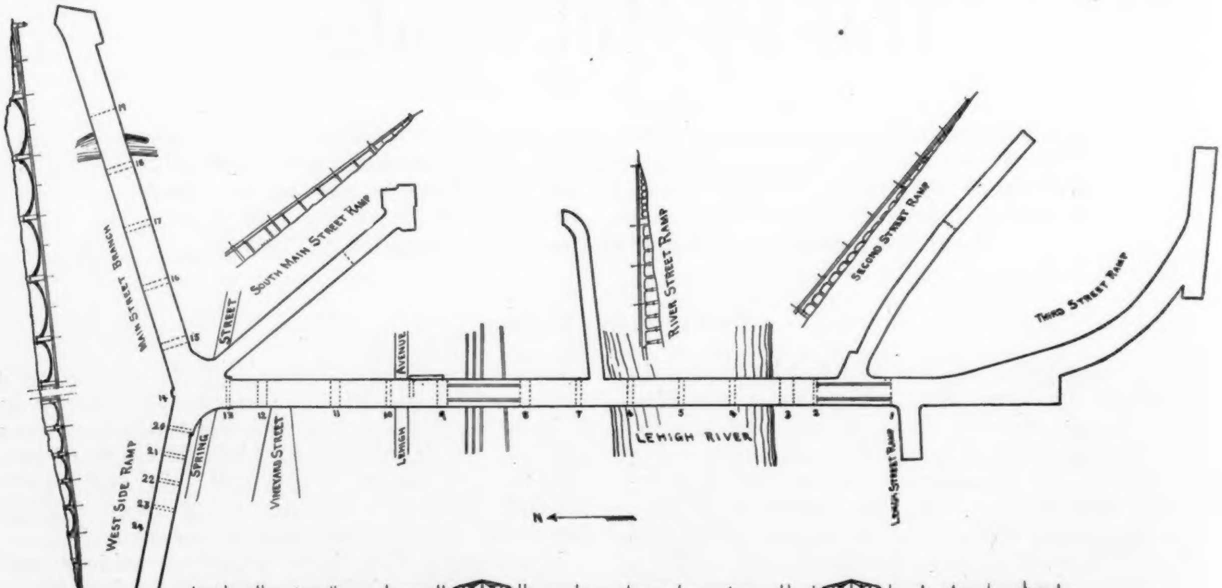


TYPICAL LONG SPAN OF MAIN BRIDGE.

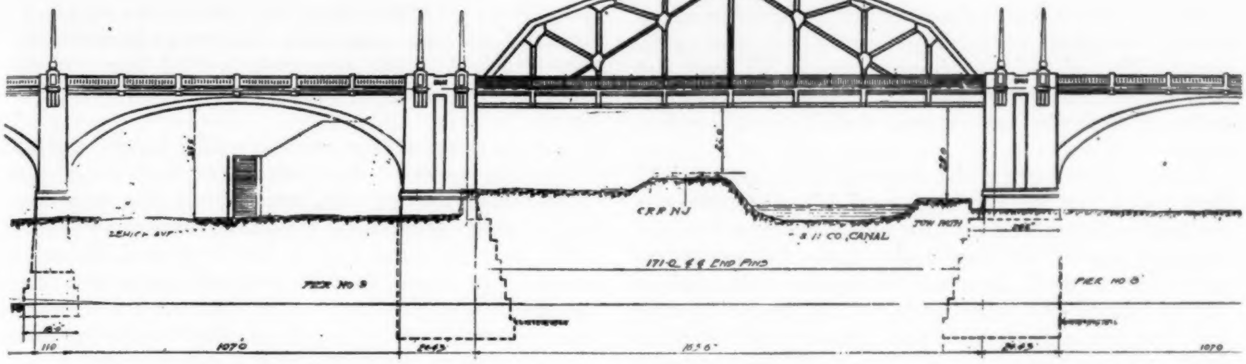
GENERAL DESCRIPTION

The main bridge, crossing the Lehigh river and valley, several railroad tracks, streets and a canal, is a tangent 2,085 feet long and 63 feet wide over all. Its roadway is carried at a level grade 57 feet above low-water level in the Lehigh river. It has ten main reinforced concrete arch spans and two steel truss spans, and is approached at both ends and on both sides by seven entrance ramps at various grades and chiefly of concrete girder construction.

Except for the long steel trusses, the main bridge has flat, barrel arches and solid spandrel walls continuous over the piers and surmounted by a molded cornice and a simple, heavy concrete balustrade carrying 100 obelisk-like, reinforced concrete electric poles on both sides of the roadway at piers and intermediate points. The piers are of two types, narrow and wide, according to the requirements of the arch spans, some of which give unbalanced thrust at the skewbacks. The intrados of the arch is continuous beyond the pier surface down to a projecting course that terminates the substructure several feet below the skewback. The upper part of the pier is a plain, tapered shaft that, in the wide piers alone,



PLANS AND ELEVATIONS OF MAIN BRIDGE AND APPROACH RAMPS.



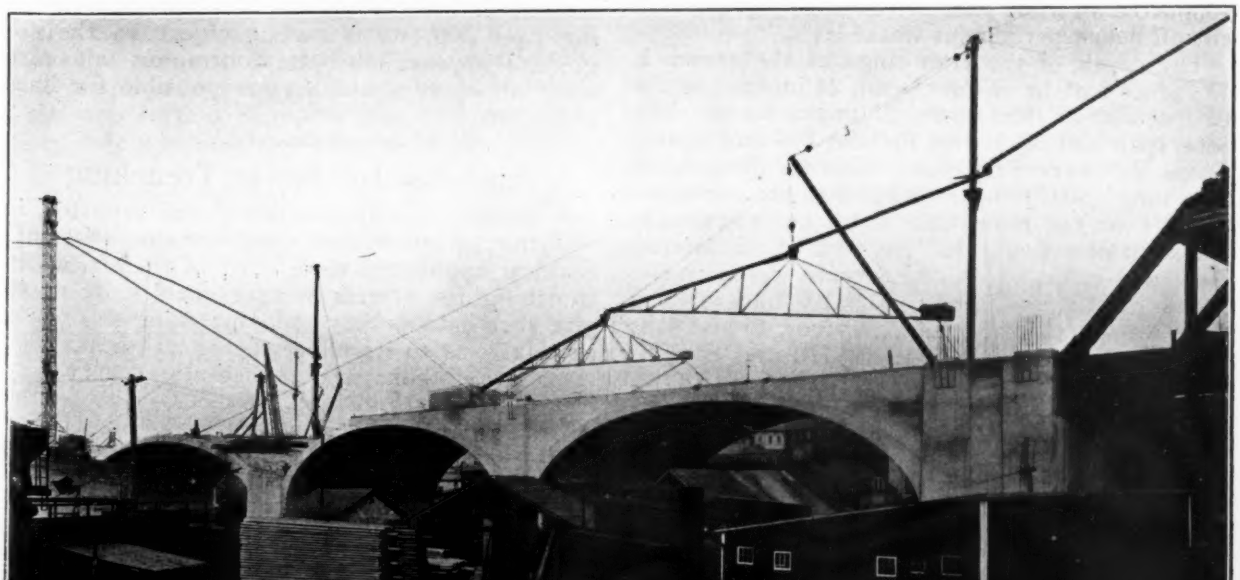
ONE OF DUPLICATE SPECIAL STEEL TRUSS SPANS FLANKED BY REGULAR ARCH SPANS.

is relieved by a narrow, center panel, above which two central panels are corbelled symmetrically to support the pair of electric poles; while on the narrow piers there is only a single corbelled panel and pole at each side of the roadway. Where some of the ramps intersect the main structure, the roadway platform is extended to eliminate sharp corners and the floor is supported on columns, girders, or piers, in some cases carrying groined arches that required complicated construction to secure a satisfactory and attractive appearance.

The granite pavement with concrete foundation is carried on a solid earth fill between the spandrel walls, which, with the arch, are waterproofed and are provided with a thorough drainage system. The main spans have a 44-foot roadway with two trolley tracks and two 7½-foot sidewalks with electric light and power ducts underneath, accessible through manholes. The side ramps have one 7½-foot sidewalk, one trolley line, one trolley track and one 36-foot roadway. The other ramps are narrower with single sidewalks and a minimum roadway of 21-foot width, the Second street ramps only carrying a trolley track.

The favorable positions of supports for the roadway of the South Main street ramp, which is 511 feet long and 38 feet wide in the clear, were so irregularly located that steel construction only was practicable, and a plate girder viaduct was adopted with a maximum girder length of about 100 feet. In general, the ramps are of reinforced concrete column and girder construction with spans of 15 to 30 feet. Beyond the abutment walls the pavement, with grades varying from 4% to a maximum of 8.9, is supported on solid earth fills between vertical retaining walls from 193 feet to 530 feet in length. The aggregate length of the ramps is 3,995 feet.

The bridge is designed for the heaviest city traffic and is proportioned to carry 24-ton motor trucks, and two continuous lines of trolley cars with loads of 30,000 pounds per axle, with additional impact allowance of about 50% of the live load and very conservative unit stresses.



TOWERS, MASTS AND CHUTES FOR SPOUTING CONCRETE TO MAIN SPANS, PIERS AND PORTIONS OF RAMPS.

ARCH SPANS AND PIERS

There are in the main structure eighteen reinforced concrete arch spans, including one with clear width of 147 feet for one span, 129 feet for four spans, 107 feet for five spans, 88 feet for one span, 65 feet for two spans, and 56 feet for five spans.

The requirements of a vertical clearance of 22 feet for a transverse width of 170 feet for the oblique intersection of the right-of-way for the railroad tracks passing under span 1-2 were too great for an arch span at this point, although it would have been more economical, and a special 171-foot through steel truss span was adopted, a duplicate to the span 8-9 over railroad tracks and the canal and towpath. A special type of truss, indicated in the elevation, was required for span 1-2 to permit it to receive, midway between piers, a wide roadway of the Second street ramp, clearance for traffic on which eliminated the possibility of diagonals in three panels of one truss, thus necessitating a design of floor suspended from pairs of inclined semi-trusses, that was worked out in extra heavy construction, made uniform for both steel spans.

All but one of the piers are carried down to foundation on limestone rock at an average depth of about 30 feet below water level, and have footings varying from 12 x 63 feet for Pier 13 to 55 x 60 feet for Pier 14. Pier 2 has little clearance between two tracks of the Lehigh Valley Railroad, and in order to avoid the excavation of a deep open pit so close to the tracks, the pier is supported on a foundation of 100 reinforced concrete piles, 32 feet long, driven in a clay and gravel stratum. For the west side ramp, the footings in clay gravel are proportioned for loads of four tons per square foot. The steel columns supporting the plate girders of the River street ramp carry comparatively light loads and are supported on wood piles driven in clay gravel and cut off below permanent water level.

The depth of the arch rings at the crown is 15 inches for the 56-foot span, 24 inches for the 65-foot and 107-foot spans, 27 inches for the 129-foot span and 30 inches for the 146-foot spans. Spans 2-3 have reinforced concrete girders, 48 feet long and 74 inches deep that are concaved slightly on the lower side to make it resemble the soffit of a flat arch. The tons of reinforcing steel and cubic yards of concrete, respectively, in the arch spans are, for the 107-foot, 65 and 690; 146-foot, 175 and 1,242; 65-foot, 45 and 418; 88-foot, 60 and 553; 129-foot, 110 and 83; 56-foot, 30 and 195.

The majority of the arch spans have elliptical intradoses, the dimensions of major and minor axes, respectively, varying from 56 to 129 feet and from 14 feet to 26.5 feet. Each semi-arch of the 56-foot span is made with construction joints dividing it into seven sections, three of which are key sections. The semi-arches of the 129-foot spans are similarly built in ten sections each, of which five are key sections. The skewback sections of each arch are built integral with the umbrella tops of the piers. These are heavily reinforced close to the intrados and extrados with longitudinal rods that are thoroughly spliced and extend into the pier masonry. In the 129-foot span, the rods 1¼ inches in diameter are 4 inches apart on centers and are supplemented by ⅝-inch transverse rods 12 inches apart.

The continuous spandrel walls have vertical tongue and groove expansion joints at maximum intervals of 25 feet and are thoroughly dowelled to the arch rings, near the inner and outer faces, with ½-inch round rods 3 feet long and 12 inches apart. The outer face is vertical and is not reinforced, while the inner face, battered 1:4, is reinforced with ½-inch rods parallel to the surface.

Concrete is proportioned 1 cement to 3 fine aggregate for exposed surfaces of sidewalks, curbs, gutters, fascia girders and protected steel work; 1:2:4 for beams, girders, slabs, columns, arch rings and skewbacks; 1:2½:5 for main piers, abutments above ground and spandrel walls, and 1:3:5 for foundations below ground and footings. The maximum size of aggregate is ¾-inch for floor slabs, railings and lamp-posts, 1-inch for arch rings and 2 inches for plain concrete. Cement was required to develop initial set in not less than 45 minutes and final set within 10 hours, with a tensile strength of 300 pounds per square inch for 28 day tests. Sand was required to pass through ¼-inch circular screen openings, and to be at least 70% retained by a sieve having 56 meshes per lineal inch.

The extradoses of the arches, the backs of spandrel walls and some other surfaces are waterproofed with three layers of asphaltic bitumen alternating with two layers of woven cotton fabric. The fabric has a tensile strength of 30 pounds per inch, a resistance to punching of 75 pounds per square inch, and is saturated under pressure with asphaltic bitumen.

Complete general plans were furnished by the Commission, but all of the detail plans, numbering over 300, were made, subject to the engineer's approval, by the contractor, who also made all surveys and was responsible for lines and levels.

Machines for Sewer Trenching

A number of city engineers who reported, in replying to our recent questionnaire, that mechanical appliances were used in their cities in trenching for sewers were requested by us to give such data as they had concerning this work, especially as to its effectiveness and cost. The majority of those who replied stated that they had no figures to give, in most cases because the work was done by contract and not by city forces. A typical reply from a New England city states: "We have made no tabulation or estimate of the saving effected by the use of this class of machinery or tools. We know, however, that there is a very great saving by the use of ditching machines, grab buckets, carons, etc., even though some of our machinery may be out of date."

Some of the engineers, however, were able to furnish more definite information. The most

complete received at the date of this writing is that furnished by Brockton and published on another page. The city engineer of Mansfield, Ohio, W. B. Statler, replies that they have used Keystone, Parsons, Austin and Buckeye ditching machines. The last named is used on light drainage work, the Keystone on trenches for storm sewers that are wide but not deep, while the Austin and Parsons are used on deeper cuts up to 19 feet.

In making cuts up to 9 feet depth under conditions suitable for their use, ditching machines have averaged the amount of work done by thirty laborers, while in cuts of greater depth machines have done the work of more laborers per unit of time, the number increasing with the depth. One report shows that on a sewer trench 18 feet deep and 1,000 feet long where the conditions for machine work were ideal, a Parsons machine did the work of forty laborers.

"In cases where there are many cross lines of sewer, water, gas and other pipes on the line of work, or where quicksand, water or rock are encountered, or if the cuts jump suddenly from a few feet to heavy cuts and back again so that the booms have to be changed very often, and if there are obstacles in the line of the work that will hinder the progress of the machine, hand work might be more economical."

In Beaumont, Texas, according to R. M. Fulweiler, city engineer, a contractor who has recently entered into a contract for laying 10-inch to 18-inch sewer from 10 to 20 feet deep is expecting to use a trenching machine on this work. Most of the trench, however, is shallow and the soil is a sandy clay which spades readily, and what records Mr. Fulweiler has show that this work is done about as economically by hand labor as it could be done by using a machine. This shallow work is generally done by city labor and costs from 15 to 30c. per foot for digging, laying and backfilling. Larger and deeper mains, however, have all been done by contract and the contractors have used trenching machines.

Electric Controllers for Sewage Pumps*

Description of design and operation of appliances for automatic operation of pumps for small electric sewage ejector stations.

In designing sewerage systems, the engineer often encounters low-lying areas of relatively small extent which can not be drained by gravity to the desired outlet or treatment plant. The only solution generally is to lift the sewage of such area into the gravity mains. Because of the relatively small amount of sewage to be pumped, a constant attendant involves prohibitive expense and an automatic plant is necessary. For this service electricity is most commonly employed. Such plants are now furnished which are certain in operation, and consume power only when and as required by the volume of flow.

The essential elements of an automatic electric sewage ejecting station are (1) the pumping equipment, (2) the electric motor for driving the pumps, (3) the control panel for starting and stopping the motor, and (4) the pilot device which governs the operation of the electric control panel. The last three of these elements constitute the electric controlling system of the station, and upon their functioning, the reliable operation of the station depends.

This controlling system will be of either the alternating or the direct-current type, depending upon the source of electrical service available. In small municipalities, or in those located in outlying districts, the alternating-current system is commonly employed, because of the many advantages in energy transmission obtained by its use. In such a case the municipality usually

*Furnished through the courtesy of the Electrical Industries Joint Committee for Business Development.

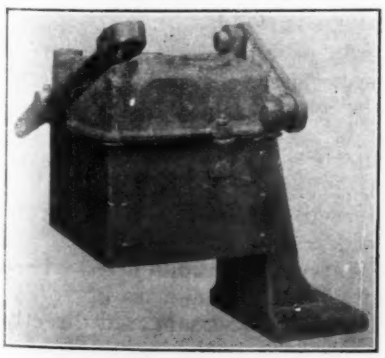


FIG. 1—ENCLOSED FLOAT SWITCH.

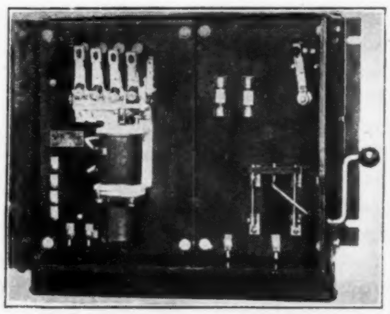


FIG. 2—AUTOMATIC STARTER; DIRECT CURRENT-RESISTANCE TYPE.

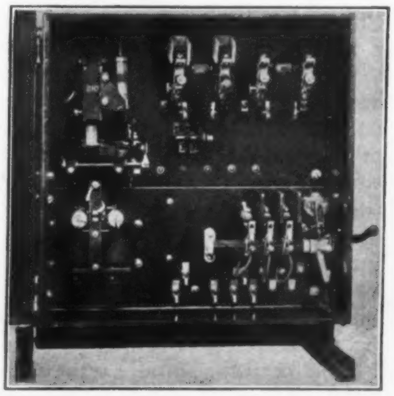


FIG. 3—PRIMARY RESISTANCE TYPE STARTER WITH CIRCUIT BREAKER.

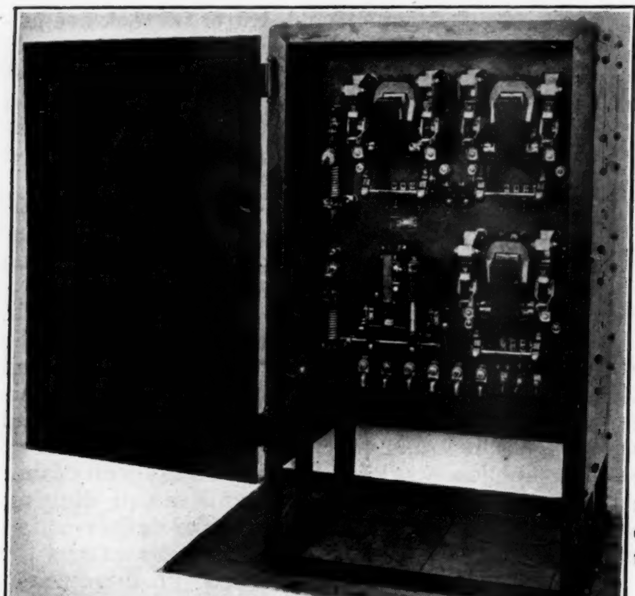


FIG. 4—TRANSFORMER TYPE SELF-STARTER: 50 H.P. 230 VOLT.

receives its electrical energy from some distant power station, which supplies alternating current to a large area. Where the current available is direct, the electrical control equipment is designed accordingly.

The pilot device used to govern the operation of a control equipment is usually a float switch, such as is shown in Fig. 1. This is a rugged device which is used in the "pilot-circuit" of the control panel. This circuit is "made" when the sewage level is high, and "broken" at a low level. The switch is actuated by a rod on which is mounted a copper float. This rod is attached to the operating arm of the pilot switch, and the pilot circuit is made and broken with the corresponding rise and fall of the sewage level. It is customary to mount the float switch near the point where it is desired to control the sewage level. There are many other methods of mounting a float switch, such as an arrangement with a chain and counterweight, with stops to actuate the lever arm. The method used is, of course, governed by the particular installation. In some cases, the float switch is incorporated in the ejecting equipment itself.

A wire cage or screen is usually provided to keep the heavy sewage from interfering with the operation of the float. The same type of pilot device is used for either alternating current or direct current. The switch takes the place of an attendant, as it operates the controller only when needed. No attention is required, and current is used only when necessary, as the float switch operates the controller only during the time it is necessary to pump out the accumulated sewage.

The control panel, which is governed by the pilot switch, is used to accelerate automatically the driving motor, and to stop the motor when the "pilot circuit" is broken. It is an automatic device and takes care of all functions necessary in starting and stopping a motor. As mentioned previously, this panel will be of the alternating-current or direct-current type, depending upon the type of motor used. Sewage-ejecting motors range from 5 to 50 horse power in rating, depending upon the demands of the locality where they are used.

All direct-current motors require some sort of starting device to bring the motor from standstill to full running speed without damaging the motor or blowing the fuses. Such apparatus starts the motor with a series of resistance in circuit, and brings the motor to full speed by shunting one resistance after another until full supply voltage is impressed upon the motor terminals. The automatic control panel performs this function automatically, and it is much more efficient in operation than any manually operated equipment as it brings the motor up to speed in the minimum time without harm.

Methods of obtaining proper acceleration by means of automatic starters are of two general types, namely, time-limit and current-limit. With the time limit method, the motor is brought up to speed in the same period of time at each start. This period can, of course, be adjusted within given limits. A common type of time limit starter is shown in Fig. 2. The timing relay consists of three chief parts; an operating solenoid, a governing dashpot, and the contacts or fingers which are used to "cut out" the starting resistance. The plunger of the solenoid is retarded in its action by the dashpot, and when the solenoid circuit is "closed" the fingers are closed in succession. An adjusting screw is provided on the dashpot, (this may be of either the oil or air type) which allows for varying the time of acceleration. The resistance material is mounted in the rear of the panel. Above 25 horsepower, the timing relay is used to control a number of magnetic switches, and these switches function to cut out the starting resistance. It will be noted that it is usual to supply a "try-out" switch on the control panel, to allow starting the equipment direct from the panel. This switch is shown in the upper right-hand panel in Fig. 2. In this illustration are also shown a main-line knife switch and fuses, for the purpose of disconnecting the equipment entirely from the line. The fuses protect the motor from excessive overloads.

With current-limit acceleration, the current required by the motor is the governong factor used in starting the motor. If the motor load is light, the motor is accelerated rapidly; if the load is heavy, the equipment is accelerated slowly. In general, however, time-limit acceleration is much preferred because of its reliability of operation and wide range of adjustment.

On alternating-current equipments, where squirrel-cage motors are used, motors up to 7½ horsepower may generally be connected directly to the line. In such a case the control panel consists of a magnetically operated switch, which is used to "throw" the motor directly

"across-the-line" to start. When the motors are of a larger capacity, some means must be provided to reduce the starting current. This may be accomplished in several ways, the most common of which are (1) by inserting resistance between the mains and motor terminals as in the case of single-phase and squirrel cage induction motors; (2) by the use of starting transformers (in the case of large motors, or those operating on high voltage, such as 2,200 volts or over) for squirrel-cage motors; and (3) by inserting resistance in the rotor circuit of slip-ring induction motors.

In any of the above methods of starting alternating-current motors, the starting period may be governed by a timing relay, or by current relays. It is usual, as with direct-current, to use the timing method of acceleration, because of its reliability of operation.

A starting panel for starting a squirrel-cage motor by the primary resistance method is shown in Fig. 3. This equipment is provided with a timing relay for acceleration. It is used for starting single-phase commutator-type motors and polyphase squirrel-cage motors driving centrifugal pumps. One step is provided for starting, the starting resistor being cut out on the second step.

In Fig. 4, a polyphase motor starter of the transformer type is illustrated. Here, also, the starting period is governed by a timing relay. Such equipments are used on large squirrel-cage motors. For high-tension squirrel-cage motors, the magnetic contractors are immersed in oil. Slip-ring motors are used when a large starting torque is required. The starting resistor in this case is inserted in the rotor circuit. The motor is accelerated by cutting out this secondary resistor until the rotor starting resistance is directly "short-circuited," and the motor is up to speed. Here again, time-limit acceleration by dashpot control is usually employed. Where current limit acceleration is used, each secondary contactor is operated by its respective current relay, which functions when the rotor current is reduced to a predetermined adjustable value.

All automatic starters of the magnetic type that are governed by a float switch in the pilot circuit inherently provide low-voltage release; that is, the equipment will function as long as the full supply voltage is impressed across the actuating coils.

For sewage-ejecting installations, it is always advisable to use enclosed panel equipments, on account of the amount of moisture surrounding the installation.

Overload protection may be provided on these equipments. This feature protects the motor from overloads. Preferably, this protection should be of the inverse-time-limit type. This type functions rapidly to open the control circuit when severe overloads occur that would probably be injurious to the motor, but it allows a brief non-injurious overload to occur, without interrupting the operation of the equipment. The equipments shown in Figs. 3 and 4 are provided with this feature. Inverse-time-limit protection is usually supplied on alternating current starters, while for direct current installations fuses are used, except where the equipments are of large capacity.

Sewerage Statistics for 1922

Engineers of several hundred cities give figures and other data concerning the amount and kinds of sewers laid last year, methods of making joints, mechanical appliances used in trenching and backfilling and in cleaning sewers, construction of sewage treatment plants, and other features of sewerage construction and operation.

Our annual sewerage statistics this year, obtained through questionnaires sent out during June, give figures for the amounts of sewers built last year by several hundred cities, these being divided into vitrified clay and cement concrete pipes, of sizes less than 24 inches, from 24-inch to 36-inch inclusive, and larger than 36-inch; also other kinds of pipe sewers, and sewers built in place composed of brick, concrete and other materials. Also information is given concerning jointing materials used other than cement, and the use of labor-saving devices in trenching and backfilling and in cleaning sewers.

THICKNESS OF VITRIFIED PIPE

Of the three hundred cities whose replies to our questionnaire were received in time for inclusion in the tabulation in this issue, 243 reported laying vitrified clay pipe sewers in 1922. In reply to the question whether standard or double-strength pipe was used, 30 reported uring double-strength for all sizes, 2 used it for sizes larger than 24-in., 5 for sizes larger than 18-in., 4 for sizes larger than 15-in., 5 for sizes larger than 12-in., 3 for sizes larger than 10-in., and 4 for some sizes not specified. Standard only was used by 103 cities, while 87 did not reply to the question. It probably may be assumed that practically all of the last used standard only. Making this assumption, we find 78 per cent. using standard thickness only. Seventy-four cities laid pipe larger than 24-inch, and of these 40 used double-strength, or 54 per cent.

SIZES OF PIPE SEWERS

Of more than nine million feet of vitrified clay pipe sewer reported as laid last year, only three per cent. was larger than 18-inch, and only two cities laid any larger than 36-inch.

About 1,656,000 feet of cement concrete pipe was laid by these cities, of which 1,516,400 feet was less than 24-inch, 65,940 was 24- to 36-inch inclusive and 74,457 feet was larger than 36-inch.

A little over 6,000 feet was cast iron, and small amounts of some other materials were used.

OTHER SEWERS

Brick sewers are still being built; in fact, these cities reported considerably more brick than concrete built in place, or 705,550 ft. of the former and 407,510 ft. of the latter. The brick sewers ranged from 22x33 in. to 93-in., and the concrete from 30-in. to 135x204-in. Of the concrete sewers, those in 20 cities were reinforced, in 3 cities part were reinforced and in 13 cities they were not reinforced.

Vitrified clay segment block sewers totaled 135,088 ft. and ranged in size from 24-in. to 126-in., twenty-one cities reporting using this type of construction.

PIPE JOINTING MATERIALS

A very large percentage of the vitrified pipe sewers laid in the country are jointed with a mixture of sand and Portland cement placed by hand, but an increasing number of cities are using other materials and methods for jointing sewers, especially where there is danger of ground water seepage. From the replies to a questionnaire sent out in June, we find the following cities using joints other than the standard sand and cement:

What is known as the G. K. compound was used last year by Brocton, Mass., on 6,300 feet of sewer, or about 40% of all the pipe laid. Reading, Mass., used it for 300 feet, or about 40%; Watertown, Mass., for 3,733 feet, the entire year's work; Laconia, N. H., also for the entire year's work, or 2,175 feet. Other cities using it were Rahway, N. J.; Summit, N. J. (400 feet); Westfield, N. J.; Binghamton, N. Y. (7,715 feet); Elmira, N. Y. (13,929 feet); Lancaster, Ohio (1,300 feet); Allentown, Pa. (45,341 feet); Westerly, R. I. (all work), and Woonsocket, R. I. (6,849 feet).

Asphaltic and other bituminous material, trade name not given, was used by St. Petersburg, Fla. (9,500 feet); Hagerstown, Md. (74,215 feet); Newark, N. J. (179 feet); Plainfield, N. J. (6,910 feet); Johnson City, N. Y. (1,000 feet); Schenectady, N. Y. (all pipe sewer); Jamestown, N. D. (600 feet); Newcastle, Pa. (1,700 feet), and Watertown, S. D.

"Filtite" was used for 1,000 feet of sewer by Long Branch, N. J., and for the same length by Minot, N. D. "Jointite" was used for 3,000 feet in Joplin, Mo., and also by Rahway and Westfield, N. J. Sulphur and sand was used in all sanitary sewers by Newton, Mass. Oil City, Pa., packed puddled clay around cement joints of 2,642 feet of pipe.

In making cement joints, Weston's form was used for 600 feet of sewer in Hartford, Conn., and 6,200 feet in Adams, Mass.

Vitrified Clay Pipe Laid in 1922

City	Less than 24-inch	24 to 36-inch	Standard or double strength
Alabama:			
Dothan	7,600 ft.	2,000 ft.	Standard
Troy	2,100 ft.	......	Standard
Arizona:			
Tucson	34,846 ft.	......	....
Arkansas:			
Pine Bluff	40,750 ft.	......	Standard
California:			
Alameda	4,500 ft.	......	Standard
Napa	400 ft.	......	....
Palo Alto	2,348 ft.	......	....
Pasadena	10 mi.	......	....
San Bernardino	12.2 mi.	......	Standard
San Diego	240 mi.	......	Standard
San Luis Obispo	12,000 ft.	......	....
Stockton	67,588 ft.	4,518 ft.	Standard
Colorado:			
Longmont	96,084 ft.	68 ft.	Standard
Connecticut:			
Bristol	1,400 ft.	......	....
Greenwich	340 ft.	......	....
Hartford	13,737 ft.	......	Over 18" D. S.
Florida:			
St. Petersburg	9,500 ft.	......	....
Sanford	21,000 ft.	......	Standard
Georgia:			
La Grange	78,600 ft.	......	....
Idaho:			
Nampa	2,000 ft.	......	....
Illinois:			
Beardstown	......	10,000	D. S.
Benton	22 mi.	0.75 mi.	Standard
Canton	1,200 ft.	......	....
Centralia	3,000 ft.	2,200 ft.	Both
Johnson City	72,738 ft.	......	....
Kewanee	35 mi.	3 mi.	Standard
Mattoon	4,500 ft.	......	Standard
Normal	1,823 ft.	......	....
Oak Park	1,418 ft.	......	....
Quincy	187,350 ft.	5,400	....
Waukegan	10,426 ft.	......	....
Indiana:			
Elwood	800 ft.	......	Standard
Fort Wayne	38,588 ft.	2,623 ft.	Standard
Gary	23,321 ft.	2,263 ft.	Over 15" D. S.
Huntington	3,000 ft.	......	....
Indianapolis	64,002 ft.	2,070 ft.	Over 18" D. S.
Lafayette	26,504 ft.	1,626 ft.	Over 24" D. S.
Marion	686 ft.	......	....
Peru	8,900 ft.	......	Standard
Rushville	1,200 ft.	......	....
Seymour	800 ft.	......	Standard
Terre Haute	2,700 ft.	......	Standard
Wabash	375 ft.	......	....
Washington	......	600 ft.	Standard
Iowa:			
Atlantic	360 ft.	......	....
Chariton	1,200 ft.	......	Standard
Clinton	3 mi.	1 mi.	Standard
Creston	3,450 ft.	......	....
Davenport	10,518 ft.	5,896	Both
Mt. Pleasant	23,000 ft.	......	Standard
Oelwein	13,000 ft.	......	Standard
Red Oak	300 ft.	......	....
Kansas:			
Atchison	3,000 ft.	......	....
Dodge City	31,000ft.	......	Standard
Emporia	29,600 ft.	......	Standard
Independence	1,800 ft.	......	Standard
Manhattan	500 ft.	2,400 ft.	....
Topeka	19,823 ft.	2,655 ft.	Mostly stand'rd
Wichita	63,954 ft.	392 ft.	Over 12" D. S.
Kentucky:			
Ashland	3,744 ft.	......	Standard
Louisville	5 mi.	2,000 ft.	Standard
Madisonvile	39,000 ft.	......	Standard
Paducah	......	9,500 ft.	D. S.
Louisiana:			
Lafayette	5,995 ft.	775 ft.	Standard
Lake Charles	3,100 ft.	......	....
Maine:			
Augusta	3,200 ft.	......	Standard
Portland	11,113 ft.	2,670 ft.	Over 12" D. S.
Rockland	1,644 ft.	......	Standard
Maryland:			
Hagerstown	73,800 ft.	415 ft.	D. S.
Salisbury	800 ft.	......	Standard
Massachusetts:			
Adams	6,200 ft.	......	Standard
Andover	8,000 ft.	......	....
Brockton	15,703 ft.	......	....
Cambridge	5,531 ft.	......	....
Fitchburg	9,931 ft.	376 ft.	Over 15" D. S.
Lowell	9,618 ft.	......	Over 10" D. S.
Medford	7,773 ft.	......	....

Vitrified Clay Pipe Laid in 1922—(Cont.)

City	Less than 24-inch	24 to 36-inch	Standard or double strength
Massachusetts (Continued)			
Natick	1,300 ft.	......	Standard
Newton	20,434 ft.	2,326 ft.	Over 12" D. S.
North Adams	4,382 ft.	20 ft.	Standard
Peabody	263 ft.	......	Standard
Reading	800 ft.	......	Standard
Taunton	4,134 ft.	......	D. S.
Waltham	4,060 ft.	......	Standard
Watertown	3,733 ft.	......	Standard
Worcester	15,393 ft.	8,303 ft.	Over 18" D. S.
Michigan:			
Battle Creek	15,470 ft.	138 ft.	D. S.
Dowagiac	4,435 ft.	......	Standard
Flint	37,991 ft.	......	Over 12" D. S.
Hastings	1,200 ft.	......	Standard
Kalamazoo	144,884 ft.	14,852 ft.	D. S.
Ludington	1,500 ft.	......	Standard
Marquette	1,600 ft.	......	....
Niles	10,000 ft.	......	Standard
Minnesota:			
Austin	5,500 ft.	10,345 ft.	D. S.[a]
Bemidji	2,175 ft.	......	Standard
Brainerd	5,035 ft.	......	....
Cloquet	3,251 ft.	......	....
Faribault	7,604 ft.	42 ft.	Standard
Hibbing	6,800 ft.	......	....
Little Falls	2,000 ft.	......	....
Minneapolis	59,000 ft.	3,763 ft.	D. S.
New Ulm	6,665 ft.	860 ft.	D. S.
Owatonna	2,800 ft.	......	....
St. Cloud	5,400 ft.	......	....
Stillwater	17,377 ft.	2,680 ft.	Over 12" D. S.
Willmar	12,000 ft.	......	Standard
Mississippi:			
Clarksdale	3,000 ft.	200 ft.	Standard
Hattiesburg	5,170 ft.	......	....
Missouri:			
Carthage	17,520 ft.	......	Standard
Fulton	500 ft.	......	Standard
Jefferson City	908 ft.	......	....
Kansas City	47,240 ft.	10,560 ft.	D. S.
Maplewood	6,782 ft.	......	D. S.
St. Louis	15,568 ft.	1,378 ft.	D. S.
Montana:			
Billings	6,970 ft.	......	Standard
Bozeman	2,328 ft.	......	Standard
Great Falls	5,247 ft.	......	....
Kalispell	2,600 ft.	......	D. S.
Livingston	400 ft.	......	Standard
Nebraska:			
Fairbury	800 ft.	......	D. S.
Kearney	12,881 ft.	......	Standard
Lincoln	42,468 ft.	121 ft.	....
North Platte	1,200 ft.	......	Standard
Omaha	132,600 ft.	7,100 ft.	D. S.
New Hampshire:			
Concord	4,330 ft.	634 ft.	Standard
Laconia	2,175 ft.	......	Standard
New Jersey:			
Bayonne	10,000 ft.	1,250 ft.	Both
Long Branch	16,000 ft.	......	Standard
Newark	11,802 ft.	......	Standard
New Brunswick	3,672 ft.	1,215 ft.	Standard
Phillipsburg	218 ft.	......	....
Plainfield	6,910 ft.	......	....
Rahway	1,200 ft.	......	Standard
Summit	400 ft.	......	Standard
Westfield	2,200 ft.	6,600 ft.	D. S.
New Mexico:			
Albuquerque	6,200 ft.	......	....
Santa Fe	7,605 ft.	......	Standard
New York:			
Binghamton	9,137 ft.	274 ft.	D. S.
Cortland	5,300 ft.	......	....
Elmira	13,929 ft.	......	Standard
Endicott	18,830 ft.	......	Standard
Geneva	5,000 ft.	......	....
Herkimer	2,600 ft.	......	....
Ilion	2,100 ft.	300 ft.	....
Johnson City	3,950 ft.	......	Standard
Kingston	3,108 ft.	......	....
N. Y.—Manhattan	3,093 ft.	......	Standard
Oneida	2,250 ft.	......	Standard
Schenectady	22,359 ft.	2,115 ft.	Standard
Tarrytown	3,000 ft.	......	Standard
North Carolina:			
Gastonia	10,000 ft.	......	D. S.
Greensboro	3 mi.	......	....
Rocky Mount	4.3 mi.	1.5 mi.	D. S.
Wilmington	4,241 ft.	......	....
North Dakota:			
Fargo	7,329 ft.	......	D. S.
Jamestown	1,855 ft.	......	Standard
Minot	6,500 ft.	......	....
Ohio:			
Akron	41,712 ft.	580 ft.	Both
Alliance	1,600 ft.	760 ft.	24" was D. S.
Ashtabula	492 ft.	......	....
Bowling Green	3,000 ft.	......	....
Chillicothe	2,696 ft.	......	....
Circleville	2,857 ft.	2,450 ft.	Over 24" D. S.
Columbus	31,484 ft.	3,148 ft.	Over 10" D. S.

Vitrified Clay Pipe Laid in 1922—(Cont.)

City	Less than 24-inch	24 to 36-inch	Standard or double strength
Ohio (Continued)			
Dayton	22,705 ft.	860 ft.	Over 12" D. S.
East Cleveland	2,312 ft.	......	Standard
Findlay	4,098 ft.	......	Standard
Fostoria	600 ft.	......	....
Fremont	950 ft.	......	D. S.
Lakewood	26,194 ft.	4,114 ft.	Over 12" D. S.
Lancaster	9,700 ft.	......	Standard
Logan	3,000 ft.	......	Standard
Mansfield	18,000 ft.	......	Standard
Marion	750 ft.	......	Standard
Middletown	9,415 ft.	......	....
Newark	11,510 ft.	1,608 ft.	Standard
Urbana	5,500 ft.	......	Over 15" D. S.
Zanesville	17,700 ft.	1,640 ft.	D. S.
Oklahoma:			
Ada	2,500 ft.	200 ft.	Standard
Henryetta	19,350 ft.	1,870 ft.	....
Muskogee	19,350 ft.	......	Standard
Vinita	500 ft.	......	....
Oregon:			
Astoria	15,150 ft.	128 ft.	....
Oregon City	1,000 ft.	......	....
Portland	2,618,686 ft.	61,998 ft.	....
Pennsylvania:			
Allentown	45,341	......	Standard
Chambersburg	5,000 ft.	......	Standard
Clairton	3.47 mi.	......	....
Clearfield	4,200 ft.	......	Standard
Connellsville	2,569 ft.	......	Standard
Du Bois	2,516 ft.	......	Standard
Dunmore	2,100 ft.	......	....
Ellwood	4,000 ft.	......	....
Hanover	3,500 ft.	......	....
Hazleton	19.85 mi.	......	....
Lebanon	11,600 ft.	......	D & W. Socket
Luzerne	583 ft.	......	D. S.
Meadville	5,042 ft.	......	Standard
New Brighton	4,500 ft.	480 ft.	D. S.
New Castle	0.499 mi.	......	....
Norristown	2,000 ft.	......	....
Oil City	10,546 ft.	......	Standard
Pittsburgh	46,037 ft.	3,446 ft.	D. S.
Pottsville	2,800 ft.	312 ft.	Standard
Rankin	200 ft.	200 ft.	Both
Sharon	14,594 ft.	2,046 ft.	Standard
Uniontown	4,000 ft.	......	....
York	1.5 mi.	......	....
Rhode Island:			
Pawtucket	8,190 ft.	742 ft.	Over 15" D. S.
Providence	191.63 mi.	......	Standard
Westerly	18,845 ft.	......	Both
Woonsocket	5,721 ft.	1,128 ft.	D. S.
South Carolina:			
Chester	532 ft.	......	Standard
Greenville	1,500 ft.	600 ft.	Standard
Orangeburg	5,350 ft.	1,350 ft.	....
Union	15,840 ft.	......	....
South Dakota:			
Aberdeen	9,000 ft.	1,000 ft.	....
Watertown	1,400 ft.	......	Standard
Tennessee:			
Clarksville	2,085 ft.	......	....
Cleveland	600 ft.	......	....
Dyersburg	75,000 ft.	......	....
Jackson	5,000 ft.	2,000 ft.	24" D. S.
Texas:			
Abilene	33,000 ft.	......	....
Amarillo	63,360 ft.	......	Standard
Beaumont	6,000 ft.	......	....
Denison	4,600 ft.	......	Standard
Denton	20,072 ft.	......	Standard
Ennis	8,252 ft.	......	Standard
San Angelo	1,200 ft.	......	....
Tyler	18.2 mi.	......	....
Weatherford	8,000 ft.	......	Standard
Utah:			
Salt Lake City	47,600 ft.	......	Standard
Virginia:			
Bristol	60,000 ft.	......	Standard
Richmond	147,509 ft.	6,508 ft.	Standard
Staunton	2,456 ft.	......	Standard
Washington:			
Port Angeles	2,877 ft.	......	....
Spokane	35,000 ft.	2,500 ft.	Over 12" D. S.
Yakima	43,775 ft.	4,875 ft.	D. S.
West Virginia:			
Bluefield	18,617 ft.	390 ft.	Standard
Fairmont	6,000 ft.	......	....
Morgantown	23,720 ft.	3,525 ft.	D. S.
Wisconsin:			
Baraboo	1,800 ft.	......	....
Madison	7,848 ft.	......	D. S.
Oshkosh	7,200 ft.	......	....
Two Rivers	10,000 ft.	......	Standard
Wausau	9,565 ft.	......	....

[a]—Also deep and wide sockets.

Note: Only two cities reported vitrified pipe larger than 36-inch—Kalamazoo, Mich., 2,969 feet, and Bayonne, N. J., 1,400 feet.

PIPE SEWERS OTHER THAN VITRIFIED CLAY LAID IN 1922

City	Cement Concrete Pipe			Other Kinds of Pipe		
	Less than 24-inch	24 to 36-inch	Larger than 36-inch	Kind	Length	Size
Alabama:						
Dothan	....	600 ft.	....	....	....	....
California:						
Napa	100 ft.	....	....	....	....	....
Palo Alto	11,251 ft.	....	....	....	....	....
San Diego	70 miles	....	....	Cast iron and kalamein	....	....
Stockton	23,783 ft.	1,396 ft.	....	....	....	....
Colorado:						
Longmont	1,940 ft.	150 ft.	....	....	....	....
Florida:						
St. Petersburg	600 ft.	....	....	Cast iron	1,300 ft	8 to 20 in.
Indiana:						
Elwood	....	....	....	Corrugated galvanized	500 ft.	....
Lafayette	....	2,810 ft.	....	....	....	....
Seymour	....	....	....	Corrugated galvanized	192 ft.	16 in.
Iowa:						
Davenport	....	616 ft.	....	Cast iron	482 ft.	16 in.
Oelwein	....	....	....	Cast iron	200 ft.	10 in.
Red Oak	....	1,800 ft.	....	....	....	....
Kentucky:						
Madisonville	....	....	....	Cast iron	300 ft.	10 in.
Maryland:						
Hagerstown	....	....	162 ft.	Cast iron	1,282 ft.	5, 20 & 24 in.
Massachusetts:						
North Adams	....	....	....	Cast iron	24 ft.	10 & 12 in.
Michigan						
Battle Creek	....	....	1,404 ft.	....	....	....
Flint	3,097 ft.	....	6,481 ft.a	Cast iron siphons	625 ft.	8 to 20 in.
Minnesota:						
Hibbing	1,500 ft.	....	....	....	....	....
Minneapolis	....	....	....	Cast iron	270 ft.	8 in.
Missouri:						
Joplin	21,790 ft.	....	....	....	....	....
Kansas City	....	....	5,625 ft.	....	....	....
Mississippi:						
Hattiesburg	1,925 ft.	1,030 ft.	....	....	....	....
Nebraska:						
Kearney	235 ft.	....	....	....	....	....
Omaha	10,000 ft.	....	3,100 ft.	....	400 ft.	12 to 24 in.
New Jersey:						
Bayonne	....	....	4,000 ft.	....	....	....
Newark	165 ft.	7,146 ft.	....	Cast iron	36 ft.	12 in.
New Brunswick	....	1,450 ft.	40 ft.	....	....	....
Plainfield	....	2,237 ft.	550 ft.	....	....	....
New Mexico:						
Albuquerque	....	1,500 ft.	....	....	....	....
New York:						
Cortland	300 ft.	....	....	....	....	....
Johnson City	....	2,470 ft.	....	....	....	....
Johnstown	1,475 ft.	....	....	....	....	....
Ogdensburg	....	850 ft.	....	....	....	....
Schenectady	1,217 ft.	....	308 ft.	....	....	....
North Carolina:						
Wilmington	6,815 ft.	692 ft.	200 ft.	....	....	....
North Dakota:						
Fargo	....	....	....	Cast iron	....	36 to 48 in.
Ohio:						
Alliance	....	1,170 ft.	800 ft.	....	....	....
Circleville	....	....	....	Cast iron	72 ft.	20 in.
Lancaster	....	900 ft.	....	....	....	....
Logan	....	....	....	Cast iron	75 ft.	36 in.
Mansfield	1,000 ft.	....	....	Cast iron	400 ft.	12 in.
Urbana	1,500 ft.	....	....	....	....	....
Oklahoma:						
Ada	....	....	....	Steel	800 ft.	12 in.
Oregon:						
Portland	915,664 ft.	19,557 ft.	....	Wood	404 ft.	....
Pennsylvania:						
Allentown	....	....	....	Cast iron	370 ft.	18 in.
Ellwood City	....	....	....	Corrugated iron	300 ft.	8 to 15 in.
Hazleton	....	....	2.9 miles	....	....	....
Norristown	900 ft.	....	....	....	....	....
Oil City	....	....	....	Cast iron	532 ft.	6 & 12 in.
Pittsburgh	....	736 ft.	....	....	....	....
South Carolina:						
Greenville	....	....	....	Cast iron	240 ft.	8 in.
Orangeburg	600 ft.	1,750 ft.	....	....	....	....
Spartanburg	6.8 miles	....	....	....	....	....
South Dakota:						
Watertown	860 ft.	710 ft.	....	....	....	....
Tennessee:						
Cleveland	600 ft.	....	....	....	....	....
Texas:						
Abilene	....	....	....	Cast iron	180 ft.	18 in.
Eastland	....	1,940 ft.	....	....	....	....
Heatherford	....	1,200 ft.	....	....	....	....
Tyler	....	....	....	Cast iron	130 ft.	6, 8 & 12 in.
Utah:						
Ogden	....	....	32,995 ft.	....	....	....
Salt Lake City	....	375 ft.a	....	....	....	....
Virginia:						
Bristol	....	....	....	Cast iron	....	....
Washington:						
Port Angeles	15,465 ft.	....	....	....	....	....
Spokane	3,500 ft.	1,300 ft.a	3,480 ft.a	....	....	....
Tacoma	13,090 ft.	11,563 ft.	....	....	....	....
Walla Walla	1,500 ft.	....	....	....	....	....

a—Reinforced.

SEWERS OTHER THAN PIPE LAID IN 1922

City	Brick		Concrete			Vitrified Clay Segment Block	
	Length	Dimensions	Length	Dimensions	Reinforced?	Length	Dimensions
Alabama:							
Dothan	....	....	1,050′	....	No	....	.....
Colorado:							
Longmont	....	....	1,105′	2½′ x 3½′ box culv.	Partially	....	.....
Florida:							
Sanford	....	....	....	....	....	900′	36″
						1,400′	33″
Illinois:							
Kewanee	½ mi.	36″ to 60″	....	....	....	....	.....
Quincy	64,670′	2x3 egg to 6.6 circular	....	....	....	....	.....
Indiana:							
Indianapolis	....	....	....	....	....	11,800′	2′-6″ to 6′
Washington	....	....	460′	5′ x 6′	....	....	.....
Iowa:							
Davenport	....	....	....	....	....	6,956′	42″
Kansas:							
						280′	42″
						400′	48″
Emporia	....	....	175′	30″ square	Yes	760′	54″
						391′	84″
						965′	96″
Wichita	....	....	....	....	....	3,960′	.....
Kentucky:							
Ashland	2,407′	54″	....	....	....	....	.....
Paducah	....	....	2,000′	8½′x8½′ semi-elipt.	Yes	....	.....
Maryland:							
Hagerstown	....	....	162′	84″ and 66″	No	....	.....
Massachusetts:							
Worcester	....	....	310′	54″ x 84″	No	....	.....
			1,084′	72″ round	Yes	....	
Michigan:							
Battle Creek	26,994′	1′-10″ x 2′-9″ to 3′-4″ x 5′-2″	4,180′	30″ to 3′-6″ x 4′-6″	No	6,288′	30″ to 42″
Kalamazoo	....	....	....	....	....	10,530′	30″ to 54″
Minnesota:							
Austin	....	....	....	....	....	2,813′	42″
Brainerd	....	....	3,750′	48″ and 54″	Yes	....	.....
Faribault	....	....	....	....	....	2,917′	36″
Minneapolis	75′	24″ and 42″ egg	9,302′	39″ egg to 102″	Yes	2,420′	36″ to 42″
New Ulm	900′	36″	3,747′	33″ to 54″	No	2,795′	30″ to 42″
Mississippi:							
Hattiesburg	....	....	1,655′	4′ x 6′ to 3′-6″ x 10′	Yes	....	.....
Missouri:							
Kansas City	....	....	5,625′	....	Yes	1,783′	.....
St. Louis	....	....	2,869′	6′ to 12′ horseshoe	Yes	....	.....
Nebraska:							
Kearney	....	....	4,200′	2′-6″ x 4′-6″ rectang.	Yes	....	.....
Lincoln	....	....	....	....	....	4,474′	.....
Omaha	6,210′	3′ to 13′					
	212′	4′ to 11′ brick and concrete	1,593′	3′-3″ to 11′-3″ x 17′	Yes	....	.....
New Jersey:							
Newark	....	....	2,198′	....	Yes	....	.....
New Mexico:							
Albuquerque	....	....	1,500′	....	Yes	....	.....
New York:							
N. Y.—Manhattan	1,720′	2′-4″ x 3′-6″	1,460′	2′-4″ x 3′-6″	Yes	....	.....
Schenectady	....	....	1,000′	5′ x 6′	Yes	....	.....
North Carolina:							
Gastonia	....	....	3,000′	6′ x 7′	Yes	....	.....
North Dakota:							
Fargo	....	....	114′	48″ circ.	Yes	....	.....
Ohio:							
Akron	....	....	....	....	....	32,210′	24″ to 126″
Columbus	....	....	....	....	....	7,853′	30″ to 42″
Dayton	....	....	18,062′	30″ to 66″	No	....	.....
Lakewood	....	....	....	....	....	1,422′	45″
Oklahoma:							
Henryetta	....	....	....	....	....	7,460′	30″ to 66″
Oregon:							
Portland	102,520′	....	316,708′	....	25%	1,393′	.....
Pennsylvania:							
Chambersburg	....	....	300′	5′ x 4′	Yes	....	.....
Norristown	....	....	900′	....	No	....	.....
Pittsburgh	9,759′	30″ to 84″ x 93″	7,330′	48″ to 84″ x 120″	No	....	.....
York	300′	42″	....	....	....	....	.....
Rhode Island:							
Pawtucket	44′	36″	1,425′	60″ and 66″	No	1,910′	60″ and 66″
Providence	91.97 mi.	....	5,183′	....	Yes	2,048′	.....
South Dakota:							
Aberdeen	....	....	....	....	....	1,100′	30″
Texas:					No		
Beaumont	....	....	700′	2½′ x 2′ horseshoe	Yes	....	.....
			3,000′	4′ x 7′ box	Yes	....	.....
Eastland	....	....	2,300′	5′ diameter	No	....	.....
Virginia:							
Richmond	140′	36″ circ.	155′	5′ x 5′ box			
			2,762′	9′ invert. horseshoe	Yes	20,280′	30″ to 57″
Washington:							
Port Angeles	1,304′	....	....	....	....	....	.....
West Virginia							
Bluefield	....	....	360′	2.5′ x 4′ and 6′ x 8′	75%	....	.....
Wisconsin:							
Madison	....	....	1,137′	2.5′ x 3′	No	....	.....
Oshkosh	....	....	4,000′	....	No	....	.....

LABOR-SAVING DEVICES

City	Devices used by city or contractor in constructing sewers		Devices used for cleaning sewers	
	Kind	Length of trench used on	Kind	Amount of work done
Arizona:				
Tucson	....	......	Self-propelling nozzle	800 ft.
Arkansas:				
Pine Bluff	Austin trenching machines and Austin backfiller	40,750 ft.	....	......
California:				
Palo Alto	Trench excavating machine	13,600 ft.	....	......
Pasadena	Trench excavating machine	......	Turbine	......
San Diego	Compressed air pavement breaker and steam and gasoline excavators	Many miles	....	......
San Luis Obispo	Trenching machine	11,000 ft.	....	......
Colorado:				
Longmont	....	......	Sewer rods	......
Connecticut:				
Hartford	Keystone excavator	4,400 ft.	Winch and bucket	......
New Haven	Keystone and Erie	......	Flushing carts	......
Georgia:				
La Grange	Austin excavator	78,600 ft.	....	......
Illinois:				
Centralia	P. & H. backfiller	......	Turbine cleaner	......
Johnson City	P. & H. backfiller, Buckeye and P. & H. excavators	......	....	......
Kewanee	....	......	Rods and hose	......
Normal	....	......	Turbine	......
Quincy	Trench machines	120,000 ft.	Name not given	......
Indiana:				
Elwood	....	......	Champion cleaner	4 miles
Gary	Erie, Keystone, Monighan	......	2 Kuhlman outfits	Always busy
Indianapolis	Keystone, Austin and Parsons excavators	......	....	......
Lafayette	Austin excavator, Parsons backfiller	......	....	......
Peru	Austin excavator and backfiller	3,000 ft.	Self-propelling nozzle	All sewers
Wabash	....	......	Sewer rods, cutting tools	......
Iowa:				
Atlantic	....	......	Stewart	......
Creston	Austin trencher and backfiller	3,450 ft.	....	......
Keokuk	....	......	Flexible steel rod	......
Mt. Pleasant	Austin trencher and backfiller	23,000 ft.	....	......
Oelwein	Austin trencher and backfiller	......	....	......
Kansas:				
Atchison	....	......	Rods and hose	......
Dodge City	Humphrey trencher	31,000 ft.	....	......
Emporia	Steam shovel, trenching machine	2,000, 25,000 ft.	....	......
Independence	....	......	Self-propelling nozzle, Stewart rods	......
Topeka	Keystone comb. ditcher and shovel, Omaha trench excavator	......	....	......
Wichita	Trench machines, pavement breakers, backfiller	10, ½, 2 mi.	Champion	Constant use
Kentucky:				
Louisville	Keystone	1 mile	Stewart	......
Madisonville	2 Austin trenching machines	39,000 ft.	....	......
Paducah	Parsons trencher, Type B; Erie shovels, backfiller	......	....	......
Louisiana:				
Lake Charles	....	......	Jointed rods	......
Maine:				
Augusta	....	......	Rods	......
Portland	Carson trench machine	2,200 ft.	Stewart	General use
Maryland:				
Hagerstown	Keystone and Carson	24,800 ft.	Victory	2,000 ft.
Massachusetts:				
Adams	Steam shovels	Depth of 4 ft.	....	......
Brockton	Parsons excavator and backfiller	14,000 ft.	....	......
Cambridge	....	......	Healey	......
Natick	....	......	Rods, with cutters and cork-screw	......
Peabody	....	......	Stewart machine	5 miles
Worcester	Erie shovel, Byers' auto-crane	......	....	......
Michigan:				
Battle Creek	....	......	Turbine sewer cleaner	4,000 ft.
Dowagiac	....	......	Self-propelling nozzle, rods	......
Flint	Steam shovel, Potter machine, Austin trencher	1,564, 1,018, 38,000 feet		
Hastings	....	......	Self-propelled nozzle	......
Marquette	....	......	Turbine	......
Niles	Austin trencher and backfiller	10,000 ft.	Rods, cable and hose	......
Minnesota:				
Austin	Monighan, clamshell, Austin and Parsons trenching machines	70,000 ft.	....	......
Cloquet	Excavator and backfiller	2,000 ft.	Self-propelling nozzles and rods	500 ft.
Faribault	Austin trencher and backfiller	5,378 ft.	Rods	......
Minneapolis	Ladder-type P. H. excavator, 3 steam hoists, 6 gas hoists, 2 pile drivers, 6 steam sheetpile drivers, steam and gas pumps, gas back-fillers, concrete mixers	......	Scrapers, discs, etc.	......
St. Cloud	Excavator and backfiller	5,400 ft.	Turbine	......
Stillwater	Parsons and Austin trenchers Austin and P. & H. backfillers	20,057 ft.	....	......
Missouri:				
Maplewood	Trencher and backfiller	4,500 ft.	Jointed rods	......
St. Louis	Trench excavator	......	....	......
Montana:				
Billings	Austin trencher	3,300 ft.	....	......
Bozeman	Austin trencher	2,328 ft.	Self-propelling nozzle, steel brushes and cable	

LABOR-SAVING DEVICES—Continued

Kalispell	....	......	Rods	......
Livingston	....	......	Rods	......
Nebraska:				
Kearney	....	......	Rods and gigs	......
Lincoln	Trench machines	30,000 ft.	Self-propelling nozzles	......
Omaha	P. & H., Parsons, Austin Humphrey	......	....	......
New Hampshire:				
Laconia	....	......	Victory nozzle and root cutter	......
New Jersey:				
Bayonne	Steam shovels, trenchers	......	....	......
Newark	Keystone excavator	......	Turbine	......
New Brunswick..	....	......	Self-propelling nozzle and rods	......
Phillipsburg	....	......	Self-propelling nozzle	......
Plainfield	Keystone excavator, tamper	......	....	......
Summit	....	......	Cable, brushes and root cutters	1 mile
Westfield	Keystone No. 6	7,000 ft.	....	......
New Mexico:				
Albuquerque	Sheetpile drivers	1,200 ft.	Self-propelling nozzle	2,000 ft.
Santa Fe	....	......	Rods	......
New York:				
Binghamton	Austin trencher and backfiller	......	Turbine	......
Cortland	Keystone excavator	......	....	......
Elmira	Austin trencher, Keystone	10,871, 2,758 ft.	Victory nozzle	......
Endicott	Austin trencher, Austin backfiller	13,800 ft.	....	......
Johnson City	Austin trencher and backfiller	......	....	......
Johnstown	....	......	Sewer rods	......
Schenectady	Excavating machine	3,500 ft.	Turbine	3,000 ft.
North Carolina:				
Rocky Mount ...	Austin excavator	......	Rods and cable	......
Wilmington	....	......	Stewart	......
North Dakota:				
Fargo	....	......	Rods	......
Jamestown	Buckeye ditcher, home-made backfiller	1,855 ft.	....	......
Minot	Parsons trencher	......	....	......
Ohio:				
Akron	Austin	......	....	......
Alliance	Keystone	3,200 ft.	....	......
Ashtabula	Thew steam shovel	7,000 ft.	Turbine	5 miles
Columbus	Keystone, Austin & steam shovel	......	....	......
Dayton	....	......	Turbine	18,600 ft.
Findlay	....	......	Self-propelling nozzle; rods and cable with cutting tools	......
Mansfield	Parsons trencher	......	....	......
Martins Ferry ...	....	......	Special nozzle	Daily
Middletown	Austin	6,800 ft.	....	......
Newark	Keystone	......	Kuhlman	......
Urbana	Trench excavators	7,000 ft.	Stewart outfit	......
Zanesville	Trenching machines and back fillers	14,000 ft.	....	......
Oklahoma:				
Ada	Austin excavator; backfiller	......	....	......
Henryetta	Steam shovel; Austin trencher	7,000; 15,000 ft.	....	......
Oregon:				
Portland	Excavators, clam-shells, steam shovels	......	Turbine	Tree roots
Pennsylvania:				
Allentown	Keystone	......	....	......
Chambersburg ..	....	......	Turbine	......
Clairton	Erie ½ yd. shovel	1½ miles	Self protecting nozzle	......
Ellwood City	Steam shovel with trenching scoop	......	Rotary nozzle	......
Hazelton	Steam shovel	3,000 ft.	....	......
Lebanon	Keystone	......	....	......
Luzerne	....	......	Victory nozzle	500 ft. of 30 in.
Meadville	....	......	Root cutting machine	Two points
Monessen	....	......	Self-propelling nozzle	500 ft.
New Brighton ...	Keystone	3,490 ft.		
Norristown	....	......	Stewart and Turbine	Several miles
Oil City	Keystone	......	....	......
Pittsburgh	Compressed air asphalt cutters; steam shovel, clam and dipper	......	....	......
Sharon	Keystone	11,420 ft.	Stewart	2 miles
Uniontown	....	......	Self-propelling nozzle	......
Rhode Island:				
Pawtucket	Trench excavator	4,300 ft.	Stewart	......
Providence	Austin and Parsons	......	....	......
South Carolina:				
Chester	....	......	Stewart	......
Greenville	....	......	Liberty nozzle	......
Orangeburg	....	......	Self-propelling root cutter	1,500 ft.
Texas:				
Abilene	Austin gasoline trencher	33,000 ft.	....	......
Amarillo	Austin backfiller	63,360 ft.	....	......
Beaumont	Monighan drag-line	......	Whirling nozzle	1,000 ft.
Eastland	Backfiller	2,000 ft.	Self-propelling nozzle	1,500 ft. of 6" & 8"
Utah:				
Salt Lake City...	P. & H. Trencher	375 ft.	....	......
Virginia:				
Richmond	Keystone; Austin cranes and trenchers	......	....	......
Washington:				
Port Angeles	Parsons No. 30	14,974 ft.	....	......
Spokane	....	......	Turbine	......
Takoma	....	......	"Ferret"	......
Yakima	P. & H. dragline excavator	7,832 ft.	....	......
West Virginia:				
Morgantown	....	......	Root cutting nozzle	......
Wisconsin:				
Baraboo	....	......	Turbine	2,000 ft.
Madison	....	......	Chicago turbine	......
Oshkosh	....	......	Milwaukee turbine	......
Two Rivers	....	......	Turbine	......
Wausau	....	......	Milwaukee turbine	......

Recent Legal Decisions

CONSTRUCTION OF SEWAGE DISPOSAL PLANT OUTSIDE CITY LIMITS AUTHORIZED

It is a matter of common knowledge that, though sewers are usually laid in streets, the outlets, flush tanks, septic tanks and other similar appurtenances which take care of the sewage flowing through and from sewers, are seldom, if ever, constructed in the streets. The California Court of Appeals, Second District (hearing denied by the Supreme Court), Federal Const. Co. v. Ensign 210 Pac. 536, holds that a statute, such as the California Improvement Act of 1911, empowering city councils to construct sewers in streets, with outlets, flush tanks, septic tanks, connecting sewers and other appurtenances "in, over or through property or rights of way owned by such city," empowers a city to construct a sewage disposal plant on its property two miles outside the city limits, connected with its sewer system over its right of way.

CONTRACTOR CONSTRUCTING DITCH ACCORDING TO PLANS AND SPECIFICATIONS NOT REQUIRED TO REMOVE SILT WASHED INTO IT AFTERWARDS

The Minnesota Supreme Court, Friederick v. Redwood County, 190 N. W. 801, states the general rule as to a contractor's duty to repair defects in work done as follows: Where a contractor makes an absolute and unqualified contract to perform a given undertaking, he assumes the risks attending the performance of the contract, and must repair any defect which develops before the completion of the work. But when he contracts to perform a given undertaking according to prescribed plans and specifications, he fulfills his engagement by doing the prescribed work in the prescribed manner, and is not responsible for defects unless due to some fault on his part, in the absence of any provision in the contract imposing some other or further obligation. So it is held that where a contractor constructs a ditch according to the plans and specifications therefor, he is not required to remove earth and silt washed into it after it was constructed unless there be a provision in the contract to that effect.

SPECIAL ASSESSMENTS FOR SEWERS—NEBRASKA

The Nebraska Supreme Court holds, Hurd v. Sanitary Sewer Dist. No. 1 of Harvard, 191 N. W. 438, that the erection of a sewage disposal plant is a general improvement, the cost of which cannot be levied upon real estate by special assessment for benefits; and the cost of main sewers in excess of special benefits can only be paid for by general taxation. A sewer assessment should be confined to lots abutting on the improvement, and there should be a finding by the board that the several lots assessed were benefited to the extent of the assessment. If the foot frontage rule is adopted there should be a finding that the benefits are equal and uniform. The court sees no reason for assessing a business lot twice as much as a residence lot.

FINAL CERTIFICATE AS EVIDENCE OF PERFORMANCE OF CONTRACT

Where a contract with a city for the erection of a bridge provided that no certificate or payment under the contract "except the final certificate or final payment, shall be evidence of the performance of this contract," the New York Appellate Division holds, Eyre v. Wood, 196 N. Y. Supp. 696, that the final certificate of the engineer, though some evidence, is not conclusive exidence of full performance.

RECOVERY ON CONTRACTOR'S BOND ON UNCOMPLETED ROAD CONTRACT

A county road-building contract required the contractor to furnish all work and material in the performance thereof. He purchased from the county court, at a reasonable price, useful and necessary machinery and material to be used in the work and to be paid for out of the moneys due him under the contract. He failed to complete the work, and the county court took it over and finished it under the terms of the contract. The West Virginia Supreme Court of Appeals holds, State v. Smith, 114 S. E. 375, that in a suit on the contractor's bond for the excess money spent in completing the contract, the county court is entitled to take the money due it for machinery and material from whatever sum was due the contractor when he quit the work, and recover from him and his bondsman the excess expenditures, less such credits and set-offs as he might be entitled to.

SPECIFICATIONS FOR PUBLIC WORKS HELD TOO INDEFINITE

The Court of Errors and Appeals of New Jersey holds, Tice v. Commissioners of City of Long Branch, 110 Atl. 25, that specifications for public work should be precise and definite upon all the essential elements that enter into the competitive scheme. Where there is no common standard there is no competition. Whatever element enters into the competitive scheme, it should be the same for all, not left for each bidder to fix for himself and thereby estimate his bid upon a basis different from that of any other bid. Following this rule, specifications inviting bids for the collection and removal of garbage, in which there is no method of disposal provided for, were held too indefinite and uncertain. A municipal contract awarded thereunder was therefore set aside.

COUNTIES NOT LIABLE FOR NEGLIGENCE OF THEIR OFFICIALS

The Iowa Supreme Court holds, Post v. Davis County, 191 N. W. 129, that, since a county is a political organization and merely a part of the organization of the state, there is no more reason or legal principle for holding the county liable for damages for negligence of its officials than the state liable for such damages for negligence of its officials.